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(54) Ink jet recording apparatus and a method for installing ink jet recording head.

(57) An ink jet recording apparatus comprises an ink tank containing ink; a recording head for performing recording by selectively ejecting ink; a mounting portion for mounting the ink

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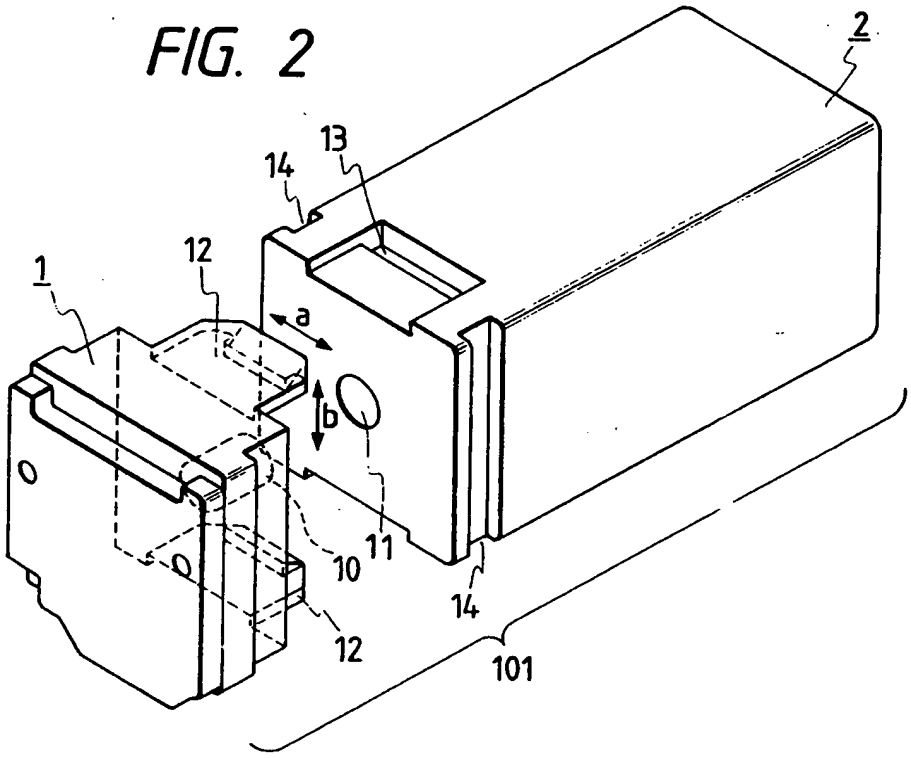
tank and the recording head; a liquid passage coupling portion provided on either or both of the ink tank and the recording head for separating or connecting the ink passages in the ink tank and the recording head; a holding portion provided on either or both of the ink tank and recording head for guiding the ink tank to the recording head in order to hold them separably; and an electrically or mechanically connecting portion provided on either or both of the recording head and mounting portion for electrically or mechanically connecting the recording head to or separating it from the mounting portion.

FIG. 2



BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to an ink jet recording apparatus using the ink jet recording method whereby to perform recording by ejecting ink, and a method for installing ink jet recording head.

Related Background Art

A number of printers, facsimile apparatuses, word processors, and other information apparatuses are being developed today. As these apparatuses, the ink jet recording method is widely used because it is capable of providing a high resolution, a high speed recording as well as a compact fabrication and a low cost. Among many other advantages, its capability of being fabricated compactly and operated at a low running cost are particularly significant.

As shown in Fig. 20, there has hitherto been a method wherein a head cartridge 1801 integrally structured with a recording head 1801a and an ink tank 1801b filled with ink is exchangeably mounted on a mounting unit 1802 of an apparatus. However, this method has a drawback that its running cost is high because the recording head in this case is an article of consumption. Also, the recording head 1801a is yet to reach its life when ink has been consumed completely. This is a waste because a recording head 1801a which is still usable for recording is discarded.

There is also a method wherein a recording head 1901 and an ink tank 1903 are structured separately and are exchangeable mounted on the mounting unit 1903 of an recording apparatus individually as shown in Fig. 21, for example. However, with this method, it is necessary to provide the ink supply passage 1904 on the recording apparatus in order to supply ink in the ink tank to the recording head. As a result, the cost is inevitably increased and this also hinders making the apparatus compact. Moreover, when ink tank containing ink materials of different colors are utilized, inkmixture takes place in the ink passages in a recording apparatus even if the recording heads 1901 and ink tanks 1902 are replaced. In order to avoid this mixture, it is necessary to the recording heads 1901, ink tanks 1902 and ink supply passages 1904 are mounted on the mounting units 1903 separately for each color.

Also, as shown in Fig. 22, for example, there is a method wherein a recording head 1701 is connected and fixed to the mounting unit 1702 of a recording apparatus while an ink tank 1703 is exchangeable connected to the foregoing recording head 1701. This method, however, makes it difficult to replace the recording heads with ease when the recording head is damaged. Also, when ink tanks having ink materials of different colors, there will take place a mixture of ink in the recording head. Accordingly, recording heads 1701 must be provided in the mounting unit 1702 separately for each color of ink.

SUMMARY OF THE INVENTION

The present invention is designed in consideration of the above-mentioned problems. It is an object of the invention to provide an ink jet recording apparatus capable of reducing the running cost, replacing ink tanks and recording heads with ease, preventing ink from being scattered when the recording heads are replaced, and replacing ink colors simply without any mixtures.

It is another object of the present invention to provide an ink jet recording apparatus capable of coupling the recording head and carriage reliably when the recording head is mounted on the carriage, at the same time keeping the easiness with which to replace the ink tanks and recording heads.

It is still another object of the present invention to provide an ink jet recording apparatus wherein the positioning precisions of the ink tank and recording head do not affect each other when the ink tank and recording head are mounted and fixed to a carriage while keeping the easiness with which to replace the ink tanks and recording heads.

An embodiment of the present invention is characterized by having ink passage means enabling the ink tank and recording head to be coupled each other and detached from each other, and coupling means enabling the recording head and the recording apparatus to be connected with each other and detached from each other.

According to such an embodiment, it is possible to reduce the running cost because the recording heads and ink tanks can be thus be replaced selectively, leading to an improvement of operational economy.

Also, the recording heads and ink tanks can be replaced integrally; hence enabling the maintenance of the recording heads and ink tanks having different ink colors. In this way, it is possible to change ink colors simply with the replacement of these heads and ink tanks thus maintained.

Furthermore, since the recording heads and ink tanks can be replaced on a carriage, the operativity is improved while preventing ink from being scattered.

Moreover, there is less opportunity to touch the recording head by hand directly. Therefore, it is possible to prevent dust particles and air to be mixed with ink; thus enabling the recording reliability to be enhanced.

According to another embodiment of an ink jet recording apparatus of the present invention, there are provided an ink passage coupling unit to allow the ink tank and recording head to be connected with each other and detached from each other as well as a cou-

pling unit to allow the recording head and the mounting unit to be connected with each other and detached from each other, the ink passage coupling unit being structured to make it possible to couple the ink tank and recording head at least in twodirections or more.

According to such an embodiment, the recording head can be mounted irrespective of the mounting directions of the ink tank; hence enabling the selections of the ink ejection direction with the result that the installation direction of the apparatus is not restricted. This will provide a flexibility for the purpose.

Also, since the ink tank is mounted on the carrier, there is no need for the provision of any ink supply tubes and others. This will enable a compact fabrication of the apparatus. In addition, when ink is completely consumed, it will suffice only if ink tanks are replaced, not the cartridge where the head is fabricated integrally therewith. Thus, the running cost can be reduced.

Also, when either one of the recording head and the ink tank should be replaced, it is good enough to replace only the one of them which requires the replacement. This will improve the operational economy.

Also, when recording heads are replaced, it is easy to separate the carrier and head. This will make the replacement easier.

Moreover, it is possible to use one kind of recording head for various modes of head cartridge, which enables its application to many different types of recording apparatuses. Hence, the versatility is enhanced to provide a desirable efficiency.

According to another embodiment of an ink jet recording apparatus of the present invention, an ink jet recording apparatus which performs recording by ejecting ink is characterized in that a recording head and an ink tank are separable and exchangeable, and that the foregoing recording head can be coupled to a carriage which carries the recording head in a given direction by pressing the foregoing recording head.

According to such an embodiment, irrespective of whether the recording head is coupled to the ink tank or not, the recording head is pressed against the carriage directly without any intervention of other members. As a result, the accuracy with which to position the recording head and carriage is highly improved. At the same time, the contacting reliability of the electrical connection to supply power from the recording apparatus to the recording head is remarkably improved to obtain an ink jet recording apparatus of an ink tank/head exchangeable type having a remarkable reliability and extremely high recording quality.

According to another ink jet recording apparatus embodying the present invention, an ink jet recording apparatus which performs recording by. ejecting ink is structured to separate the ink tank and recording head and is characterized by allowing the foregoing ink tank and recording to be mounted on a carriage by separate means, respectively.

With such an embodiment as this, it becomes possible to mount a most suitable ink tank without degrading the accuracy with which to mount a recording head to the carriage because the recording head and the exchangeable ink tank are arranged independent of each other thereby to enable the implementation of an ink jet recording apparatus demonstrating a desirable recording quality as well as a remarkable reliability, which can be operated at a low running cost.

Another ink jet recording apparatus embodying the present invention is characterized in the following:

(1) A member is arranged to mount an ink jet cartridge in a carrier detachably and hold it in the carrier for the foregoing ink jet cartridge.

(2) In an ink jet recording apparatus, an ink jet cartridge is partitioned for a recording head and an ink tank which are structured separably, a recording head is provided with a member to mount the recording head in a carrier detachably and to hold it in the carrier.

(3) In the ink jet cartridge described in Paragraph (2), an ink tank is provided with a member to mount the ink tank in the carrier detachably and hold it in the carrier.

With such an embodiment as this, there is arranged on an ink jet cartridge a member to mount the ink jet cartridge in a carrier detachably and hold it the carrier. Accordingly, it becomes unnecessary for the carrier to be provided with such a member; hence enabling the finished product to be made compact with a simple structure and an enhanced operativity.

According to another embodiment of an ink jet recording apparatus of the present invention, there are provided for an ink jet recording apparatus which performs recording by ejecting ink onto a recording medium, a carriage for mounting the foregoing recording head, which travels along the foregoing recording medium; and an ink tank detachably mountable in the foregoing recording head, and such an ink jet recording apparatus is characterized in that means for regulating the direction in which the foregoing ink tank approaches the recording head is arranged for the foregoing carriage or ink tank or the carriage and ink tank.

According to such an embodiment as this, there is arranged means for regulating the direction in which the foregoing tank approaches the recording head for the carriage and/or ink tank thereby to prevent the ink tank from causing any damage to the recording head even when an extra force is exerted by an operator when mounting the ink tank or the ink tank is pressed by mistake because the ink tank is controlled before the ink tank imparts such a pressure to the recording head.

Another ink jet recording apparatus embodying the present invention is characterized in that the head is provided with an ink supply inlet to supply ink to an ink cartridge, and a member to position the head and ink cartridge, and that the ink supply inlet is cylindrically shaped with a desirable sealingcapability while a separate member is provided for positioning the ink cartridge and head.

According to another embodiment of an ink jet recording apparatus of the present invention, there are provided for an ink jet recording apparatus which performs recording by a recording head ejecting ink droplets onto a recording medium, a carriage for mounting the foregoing recording head, which travels along the foregoing recording medium, and an ink tank detachably mountable in the foregoing recording head, wherein means for controlling the mounting direction of foregoing ink tank on the carriage only one way is arranged for the foregoing carriage or ink tank or the carriage and ink tank.

According to such an embodiment as this, means for controlling the mounting direction of the ink tank on the carriage only one way is provided thereby to avoid making any mistakes in deciding on the mounting direction of the ink tank with respect to the carriage as well as preventing any damage to the recording head due to any erroneous mounting of the ink tank.

According to another embodiment of an ink jet recording apparatus of the present invention, an ink jet recording apparatus in which an ink tank is coupled to the a recording head when the recording head is mounted in the recording apparatus, it.ischaracterized in that an indicator is provided to indicate that the recording head and ink tank has been correctly coupled.

According to such an embodiment as this, it is possible to couple the ink tank and recording head assuredly by conducting the coupling operation until positioning indications or positioning couplers provided for the ink tank and recording are matched or actuated.

Another ink jet recording apparatus embodying the present invention is characterized in the following:

(1) an absorbent is provided in the vicinity of the area where the recording head of the foregoing ink jet cartridge and the ink tank are coupled.

(2) a groove is provided in the vicinity of the area where the recording head of the foregoing ink jet cartridge and the ink tank are coupled.

(3) a hydrophilic or water repellent treatment is given to the vicinity of the area where the recording head of the foregoing ink jet cartridge and the ink tank are coupled.

According to such an embodiment as this, it is possible to prevent ink leakage and ink splashing by providing the absorbent, groove, and hydrophilic and/or water repellent treatment. Thus, an ink jet recording apparatus can be provided so as to contribute to the enhancement of the reliability and safety of a finished product.

In another ink jet recording apparatus embodying the present invention in which recording is performed by ejecting ink onto a recording medium, such an ink jet recording apparatus is characterized in that there are provided a recording head to eject ink; an ink tank which contains ink to be supplied to the foregoing recording head and is detachable together with the foregoing recording head with respect to the foregoing ink jet recording apparatus, the ink tank being interrelatedly detachable with the foregoing recording head; detecting means to detect whether the ink tank is mounted in the ink jet recording apparatus or not; and controlling means to control the recording operation of the ink jet recording apparatus on the basis of the detected results of the aforesaid detecting means.

Also, it should more preferably be characterized that the aforesaid detection means serves dually as detecting means to detect the amount of ink in the aforesaid ink tank.

According to such an embodiment as this, it becomes possible to suppress any recording operation in the ink jet recording apparatus when the ink tank is not mounted; thus enabling the prevention of an exhaustion of ink or the like in the midway of recording operation.

Also, even when an empty ink tank is erroneously mounted for recording, such an operation can be prevented; thus making it possible to prevent air from being mixed into the recording head or ink leakage from the recording head.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view schematically illustrating an embodiment of an ink jet recording apparatus according to the present invention.

Fig. 2 is a schematic partial enlargement perspectively illustrating the embodiment.

Fig. 3 is a cross-sectional view of a partial enlargement of the embodiment.

Fig. 4 is a perspective view schematically illustrating a first mode of an exchangeable type according to the embodiment.

Fig. 5 is a perspective view schematically illustrating a second mode of an exchangeable type according to the embodiment.

Fig. 6 is a schematic plan view illustrating the way in which pressure is exerted by the embodiment.

Fig. 7 is a perspective view schematically illustrating the entire body of a recording apparatus for an ink jet recording apparatus embodying the present invention.

Fig. 8 is a cross-sectional view showing an ex-

changeable ink tank according to the embodiment.

Fig. 9 is a perspective view illustrating an example of an ink jet recording apparatus to which the present invention is applicable.

Figs. 10A and 10B are schematic perspective views illustrating an information processing apparatus using an ink jet recording apparatus according to the present invention.

Fig. 11 is an electrical circuit diagram showing an information processing apparatus using an ink jet recording apparatus according to the present invention.

Fig. 12 is a flowchart showing the recording operation according to the embodiment.

Fig. 13 is a schematic plan view illustrating another embodiment.

Fig. 14 is a schematic plan view illustrating a second type according to another embodiment.

Figs. 15A, 15B, and 15C are schematically cross-sectional views showing the structures of still another embodiment.

Fig. 16 is a schematically cross-sectional view showing the structure of the embodiment shown in Fig. 15.

Figs. 17A and 17B are schematically cross-sectional views showing the structure of a further embodiment.

Figs. 18A and 18B are schematic plan views showing still a further embodiment.

Fig. 19 is an electrical circuit diagram showing the structure of still another embodiment.

Fig. 20 is a schematically cross-sectional view illustrating a prior art.

Fig. 21 is a schematically cross-sectional view illustrating a prior art.

Fig. 22 is a schematically cross-sectional view illustrating a prior art.

Fig. 23 is a schematically cross-sectional view illustrating the state where an exchangeable recording head and exchangeable ink tank according to another embodiment are mounted on a carriage.

Fig. 24 is a schematically cross-sectional view illustrating a mounting sequence.

Fig. 25 is a schematically cross-sectional view illustrating an exchangeable tank.

Fig. 26 is a schematically cross-sectional view illustrating the state where an exchangeable recording head and exchangeable ink tank according to another embodiment are mounted on a carriage.

Fig. 27 is a schematically cross-sectional view illustrating a mounting sequence for an recording head and an exchangeable ink tank.

Fig. 28 is a view illustrating the coupling of an recording head and exchangeable ink tank.

Fig. 29 is a view illustrating the recording head according to the embodiment shown in Fig. 26 viewed from the direction in which ink is ejected.

Fig. 30 is a schematically cross-sectional view illustrating the state where an exchangeable recording head and exchangeable ink tank according to still another embodiment are mounted on a carriage.

Fig. 31 is a partially sectional view illustrating the embodiment shown in Fig. 30 viewed from the direction in which ink is ejected.

Fig. 32 is a schematically cross-sectional view illustrating an exchangeable ink tank.

Fig. 33 is a schematically cross-sectional view illustrating the state where an exchangeable recording head and exchangeable ink tank according to still another embodiment are mounted on a carriage.

Fig. 34 is a schematically cross-sectional view illustrating a mounting sequence for an recording head and an exchangeable ink tank.

Fig. 35 is a partially sectional view illustrating the embodiment shown in Fig. 33 viewed from the direction in which ink is ejected.

Fig. 36 is a schematically perspective view illustrating another embodiment.

Fig. 37 is a schematically perspective view illustrating the state where the head cartridge shown in Fig. 36 is mounted on a carrier.

Fig. 38 is a cross-sectional view schematically showing the coupling portion of the ink passage shown in Fig. 36.

Figs. 39A and 39B are cross-sectional views illustrating the structure of another embodiment.

Fig. 40 is a schematically perspective view illustrating the structure of still another embodiment.

Fig. 41 is a schematically perspective view illustrating the structure of a further embodiment.

Fig. 42 is an exploded view illustrating a carrier and ink jet cartridge according to another embodiment.

Fig. 43 is a view illustrating the operation of an ink jet cartridge mounting and holding lever.

Fig. 44 is an exploded view illustrating a carriage and ink jet cartridge according to still another embodiment.

Fig. 45 is an exploded view illustrating a carriage and ink jet cartridge according to a further embodiment.

Fig. 46 is an exploded view illustrating the ink jet cartridge shown in Fig. 45.

Fig. 47 is an exploded view illustrating a carrier and ink jet cartridge according still a further embodiment.

Fig. 48 is a schematically perspective view illustrating a carriage before an ink tank is mounted.

Fig. 49 is a schematically perspective view illustrating the carriage after the ink tank is mounted.

Fig. 50 is a schematically perspective view illustrating a carriage before an ink tank is mounted.

Fig. 51 is a schematically perspective view illustrating the carriage after the ink tank is mounted.

Fig. 52 is a schematic view illustrating the positional relations between an recording head, ink tank groove, and the boss of a carriage lever.

Fig. 53 is a schematically perspective view illustrating an ink tank.

Fig. 54 is a side view schematically illustrating an ink tank.

Fig. 55 is a schematically perspective view illustrating a carriage before an ink tank is mounted.

Fig. 56 is a schematically perspective view illustrating the carriage after the ink tank is mounted.

Fig. 57 is a schematically perspective view illustrating an ink tank.

Fig. 58 is a schematically perspective view illustrating a carriage before an ink tank is mounted.

Fig. 59 is a schematically perspective view illustrating the carriage after the ink tank is mounted.

Figs. 60A and 60B are schematic views illustrating another embodiment.

Fig. 61 is a schematic view illustrating still another embodiment.

Fig. 62 is a schematic view illustrating a further embodiment.

Fig. 63 is a schematically perspective view illustrating a carriage before an ink tank is mounted.

Fig. 64 is a schematically perspective view illustrating the carriage while the ink tank is being mounted.

Fig. 65 is a schematically perspective view illustrating the carriage after the ink tank is mounted.

Fig. 66 is a schematically perspective view illustrating an ink tank.

Fig. 67 is a schematically perspective view illustrating a carriage before an ink tank is mounted.

Fig. 68 is a schematically perspective view illustrating the carriage while the ink tank is being mounted.

Fig. 69 is a schematically perspective view illustrating the carriage after the ink tank is mounted.

Fig. 70 is a schematically perspective view illustrating an ink tank.

Fig. 71 is a side view schematically illustrating the ink tank.

Fig. 72 is a schematically perspective view illustrating a carriage before an ink tank is mounted.

Fig. 73 is a schematically perspective view illustrating the carriage after the ink tank is mounted.

Fig. 74 is a schematically perspective view illustrating an ink tank.

Fig. 75 is a schematically perspective view illustrating a carriage before an ink tank is mounted.

Fig. 76 is a schematically perspective view illustrating the carriage after the ink tank is mounted.

Fig. 77 is a schematically perspective view illustrating the state where an ink jet recording head and ink tank according to another embodiment are parted.

Fig. 78 is a schematically perspective view illustrating the state where the ink jet recording head and ink tank are being coupled.

Fig. 79 is a schematically perspective view illustrating the state where the ink jet recording head and ink tank are coupled.

Fig. 80 is a schematic view illustrating the state where a head cartridge is being mounted on a carrier.

Fig. 81 is a schematic view illustrating the state where a head cartridge is being mounted on a carrier.

Fig. 82 is a schematic view illustrating the state where the head cartridge is mounted on the carrier.

Fig. 83 is a schematically perspective view illustrating the state where a recording head and ink tank according to still another embodiment is parted.

Fig. 84 is a schematic view illustrating the state where the recording head and ink tank are coupled.

Fig. 85 is a schematically perspective view illustrating the state an recording head and ink tank according to still another embodiment are coupled.

Fig. 86 is a schematically perspective view illustrating another way in which the recording head, ink tank, and carrier are coupled.

Fig. 87 is a partially perspective view schematically illustrating the structure of a carrier and ink jet cartridge according to another embodiment.

Fig. 88 is a partially perspective view schematically illustrating the structure of a carrier and ink jet cartridge according to still another embodiment.

Fig. 89 is a partially perspective view schematically illustrating the structure of an ink jet cartridge according to a further embodiment.

Fig. 90 is a partially perspective view schematically illustrating the structure of the ink jet cartridge.

Fig. 91 is a partially perspective view schematically illustrating the structure of an ink cartridge according to another embodiment.

Fig. 92 is a partially perspective view schematically illustrating the structure of an ink cartridge according to still another embodiment.

Fig. 93 is a block diagram showing the setup for an ink tank detection according to a further embodiment.

Fig. 94 is a block diagram showing the setup for an ink tank detection according to still a further embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, with reference to the accompanying drawings, the description will be made in detail of the embodiments according to the present invention.

Fig. 1 is a schematically perspective view illustrating the recording head unit and carrier unit of a recording apparatus embodying the present invention. In Fig. 1, a reference numeral 1 designates a recording head which ejects ink in accordance with electric signals; 2, an ink tank containing ink to supply it to the recording head 1; 102, a carrier provided for the recording apparatus body to hold the recording head 1 and ink tank 2; 106, a head lever to hold or release the recording head 1; 107, an ink tank lever to mount or

demount the ink tank 2; and 108, a head fixing spring to fix the recording head 1 to the carrier 102. With these components, the recording head unit and carrier unit are constituted.

Fig. 2 is a schematically perspective view illustrating the recording head 1 and ink tank 2 according to the embodiment of the present invention. In Fig. 2, a reference numeral 10 designates the ink supply inlet which serves as the ink passage for ink to be supplied from the ink tank 2 to the recording head 1; 11, an ink supply outlet to supply ink from the ink tank 2 to the recording head 1; 12, coupling nails to guide and hold the recording head 1 and ink tank 2 when integrally coupled; 13, coupling nail guiding grooves to engage with the coupling nails 12; and 14, ink tank holding grooves to hold the ink tank 2 when the ink tank 2 and recording head 1 are mounted or demounted. With these elements, a head cartridge 101 is constituted.

The recording head 1 comprises a substrate on which are formed a plurality of electrothermal transducers to generate thermal energy to be utilized for ejecting ink and a driving circuit to drive them; discharging ports and liquid passages corresponding to each of the above-mentioned plural electrothermal transducers; and further a ceiling board laminated thereon to constitute a common liquid chamber conductively connected to each of the liquid passages. Then, the recording head thus structured is mounted on the apparatus in such a manner that the discharging port surface having the discharging ports of the head are placed to face a recording medium.

The ink tank 2 is a tank which holds ink therein and supplies it to the recording head 1 appropriately in order to refill the ink which has been consumed by recording. If two single bodies constitute an ink tank, the ink supply outlet 11 is sealed by sealing means (not shown) to prevent any ink leakage therefrom. This sealing means is automatically or manually released when the ink tank is coupled to the recording head 1 to enable the ink supply. Also, it may be possible to arrange a mechanism so that air is introduced from the outside as the volume of ink is being reduced by the ink consumption. Further, it may be possible to provide a mechanism in the inside to keep a pressure exerted slightly negative on the ink to be supplied to the recording head for the purpose of improving the printing quality as well as preventing any ink leakage.

The recording head 1 and ink tank 2 are used for a recording apparatus in operation in a form of a cartridge 101 which is integrally fabricated with them. Now, the description will be made of the way in which to integrate them.

Fundamentally, the recording head 1 and ink tank 2 are integrated by coupling the ink supply inlet 10 and ink supply outlet 11. Therefore, this portion is carefully arranged to prevent ink leakage from or air intake into the ink passages. In the present embodiment, as shown in Fig. 13A, a method is adopted to utilize the resiliency of a mold member for the purpose. In other words, the ink supply inlet hole 10a and the ink supply outlet hole 11a are formed cylindrically and then the inner diameter of the ink supply outlet 11a is slightly smaller than the outer diameter of the ink supply inlet hole 10a. Thus, when the ink supply inlet hole 10a is pressed into the ink supply outlet hole 11a, these two holes are tightly integrated while being slightly deformed in the radial direction. Also, the coupling portion is not necessarily of a mold member, but it will suffice only if the material has a sealing capability. The other coupling methods will be described later.

In the integration of the recording head 1 and ink tank 2, while it is good enough to couple the ink supply inlet 10 and ink supply outlet 11 as described above, the coupling is intensified in the present embodiment by providing the coupling nails 12 and coupling nail guiding grooves 13 in order to prevent them from being disengaged simply due to any unexpected force that may be exerted when the head cartridge 101 is handled or to facilitate the integration. In other words, the coupling nails 12 formed integrally with the ink supply inlet 10 by molding and capable of being resiliently deformed are provided with protrusions at the leading ends, and are fitted into the coupling nail guiding grooves 13 while being resiliently deformed by the portions corresponding to the height of the protrusions. The coupling is completed when the protrusions of the coupling nails 13 reach the deepest portions arranged in the rear sides of the coupling nail guiding grooves 13.

Further, the coupling nails 12 serve as guides so as to allow the ink supply inlet 10 and ink supply outlet 11 to be easily fitted when the recording head 1 and ink tank 2 are coupled. In other words, the coupling nails 12 are made longer than the ink supply inlet 10 so that the coupling nails 12 are to be in contact with the ink tank 2 before the ink supply inlet 10 reaches the ink supply outlet 11. Here, the leading ends of the coupling nails 12 are cut off diagonally. This diagonally cut off portion serves as its guide in the direction indicated by an arrow a in Fig. 2 to facilitate the engagement with the coupling nail guiding grooves. Also, the protrusions provided at the leading ends of the coupling nails 12 are also cut off diagonally to promote an easier engagement by serving as its guide in the direction indicated by an arrow b in Fig. 2.

In this respect, while the coupling nails are provided on the recording head side in the present embodiment, its position is not confined thereto. It may be possible to position them on the ink tank 2 side or on both sides of the recording head 1 and ink tank 2.

Now, the description will be made of the mechanical and electrical connections of the recording head 1 to the carrier 102.

Fig. 3 is a cross-sectional view illustrating the

portion where the carrier 102 is coupled to the recording head 1 viewed in the direction indicated by an arrow a in Fig. 1, in which a reference numeral 109 designates a positioning pin which is fitted into a hole provided for the recording head 1 fixed to the carrier 102 to set the position in the vertical direction in Fig. 3 and in the direction perpendicular to the plane thereof; 110, a stopper fixed to the carrier 102 to receive the recording head 1 which is pressed in the direction indicated by an arrow a in Fig. 3; 401, a flexible cable electrically connecting the recording apparatus body and the recording head 1; 111, a pad placed between the flexible cable 401 and the carrier 102 to support the flexible cable 401 resiliently; and 15, a contact provided for the recording head 1 and electrically connected to a heater unit in the recording head 1.

The recording head 1 is pressed in the direction indicated by an arrow a by means of the head fixing spring 108 through a lever which is not shown. Its position is unanimously fixed by the hole provided for the recording head 1, the positioning pin 109, and the intervention of the stopper 110. In this way, the recording head 1 and carrier 102 are mechanically coupled.

Also, there are arranged a plurality of electrically contacting points on the contact 15 of the recording head 1 and the end of the flexible cable 401 in the positions opposite to each other. By pressing them with a given pressure, the recording apparatus body and the recording head 1 are electrically connected. At this juncture, the plural electrically contacting points must be in contact under compression. To this end, the pad 111 made of a resilient material is inserted in the compressing portion so as to press those contacting points evenly. The material of the pad 111 is silicon rubber, for example, and it is arranged that the reaction force exerted thereby when depressed is made much smaller than the force exerted by the head fixing spring 108 which presses the recording head 1.

Particularly, the electrical contact provided for the flexible cable 401 may be extruded when configured in order to cause the reaction force to be concentrated when depressed so that the connection is made reliably.

In this respect, the electrical or mechanical connections are arranged on the recording head side in the present embodiment, but irrespective of this arrangement, the connections may be arranged on the ink tank 2 side or on both sides of the recording head 1 and ink tank 2. Also, it may be possible to arrange the electrical connections and the mechanical connections separately on either side, respectively.

Now, the description will be made of the handling of the recording head 1 and ink tank 2, that is, the method to replace an exhausted ink tank 2 with a new ink tank 2 or to replace the recording head 1 which is disabled to be used any more due to some causes.

As a first mode, the fixation between the recording head 1 and carrier 102 is released. From the carrier 102, the recording head 1 and ink tank 2 are removed as they are still in a coupled state. Then, in a state where they are detached from the carrier 102 (hereinafter referred to as off carrier condition), the recording head 1 and ink tank 2 are separated or coupled.

Fig. 4 is a schematically perspective view illustrating the state where the recording head 1 and ink tank 2 are removed from the carrier 102 as they are still in a coupled condition. In this case, the head lever 106 is pulled up from the state as shown in Fig. 1 to the position shown in Fig. 4A rotatively in the direction indicated by an arrow a. Thus, the pressure exerted to the recording head 1 by the head fixing spring 108 is released. At this juncture, the recording head 1 and ink tank 2 are shifted in the direction indicated by an arrow b as they are still in a coupled condition by a lever (not shown) arranged in the carrier 102. This causes the engagement between the positioning pin 109 and the hole of the recording head 1 to be disengaged; hence enabling the recording head 1 and ink tank 2 to be shifted in the direction indicated by an arrow c in Fig. 4 as they are still in a coupled state, and to be in the off carrier condition. In the off carrier condition, a force is given in a direction opposite to the direction in which the recording head 1 and ink tank 2 are coupled to separate them and replace the one which requires the replacement. Then, by the coupling method described earlier, both of them are integrated and mounted in the carrier 102 in the reversed order to terminate the replacement operation.

In this respect, the head lever 106 is used to release the pressure exerted on the recording head 1 in the present embodiment, but irrespective of this method, it may be possible to make an arrangement so that the lever which presses the recording head 1 can be shifted directly. Also, irrespective of the method wherein the head fixing spring 108 is used to press the recording head for its fixation, it may be possible to use a latch hook or the like having a spring capability for the head fixation.

Furthermore, it may be possible to mount or demount the recording head 1 and ink tank 2 in the coupled state by holding the recording head 1 directly against the pressure exerted by such a pressing means.

When the first mode is adopted, the following effects are obtainable:

When either one of the recording head and ink tank must be replaced, it is possible to replace only the one which needs the replacement. Therefore, the operational economy is improved.

Also, the recording head 1 and ink tank 2 can be replaced as they are in the coupled condition. The recording heads and ink tanks having different colors can be retained as they are in the off carrier condition. Therefore, it becomes simple to change record-

ing colors.

As a second mode, the recording head 1 and ink tank 2 are separated on the carrier 102 while the recording head 1 and carrier are still fixed (hereinafter referred to as on carrier condition).

Fig. 5 is a schematically perspective view illustrating the state where the ink tank 2 is separated from the recording head 1 on the carrier 102. In this case, by pulling up the tank lever 107 from the state shown in Fig. 1 to the position shown in Fig. 5A rotatively in the direction indicated by an arrow a, a lever (not shown) arranged in the carrier 102 engages with the ink tank guide groove 14 which is provided on the side of the ink tank 2 and is shifted in the direction indicated by an arrow b in Fig. 5. At this juncture, the fixation of the recording head 1 is in the same state as Fig. 1, and it is not shifted together with the ink tank 2. Accordingly, the engagement between the recording head 1 and ink tank 2 are disengaged; thus enabling them to be separated. Further, by allowing the ink tank 2 to be shifted in the direction indicated by an arrow c in Fig. 5, it can be removed from the carrier 102.

In this respect, if the recording head 1 is resiliently pressed by the head fixing spring 108 as in the present embodiment, there is a possibility that the head fixation is released depending on the way the separating force is exerted. It is preferable to arrange the structure as follows:

Fig. 6 is a schematic plan view showing the way in which such a force is exerted. In Fig. 6, the recording head 1 is pressed by a force f1 exerted by the head fixing spring 108 to the carrier 102. Also, it is assumed that a force f2 is needed to disengage the coupling nails 12 and the ink supply inlet 10 in order to separate the recording head 1 and ink tank 2. In this case, it is possible to prevent the fixation of the recording head 1 to be released in the separating operation by defining the strengths of the forces as f1 > f2.

Here, in the present embodiment, the separation is executed by exerting a force equivalent to the force f2 using a tank lever 107, but irrespective of this method, it may be possible to arrange the structure so that the ink tank 2 is pulled up in the direction indicated by an arrow b in Fig. 5 by holding it directly to separate the recording head 1 and ink tank 2.

When the second mode is adopted, there are the following effects in addition to those obtainable in the first mode:

It is possible to control the speed with which the ink tank is pulled out when it is separated by designing the cam configuration of the tank lever 107; thus enabling the prevention of the ink scattering from the ink supply inlet 10 and ink supply outlet 11.

Also, there is no need for holding the recording head 1 by hand directly. Accordingly, there is no possibility that a hand touches the vicinity of the ink ejection nozzles of the recording head 1. Hence, it is possible to prevent any unwanted contamination which may produce adverse effects on printing.

Also, the portion where the force exerted by the ink tank 2 can be specified. Therefore, it will suffice only if such a portion is reinforced. All the other portions can be structured thin to make the ink tank lighter with a more ink containing capability among other effects.

Subsequently, the description will be made of the structure and operation of a recording apparatus wherein the above-mentioned recording head 1, ink tank 2, and carrier 102 are mounted.

Fig. 7 is a schematically perspective view illustrating the outline of a recording apparatus embodying the present invention.

A carrier 102 with a head cartridge 101 being mounted has a pin (not shown) to be engaged with the spiral groove 105 of a lead screw 103 which is interrelated with the normal and reverse rotations of a carrier motor 402a and rotated through a transmission mechanism (not shown). Thus, the carrier is reciprocated in the directions indicated by arrows a and b following the rotation of the lead screw 103. Here, a reference numeral 104 designates a slide shaft to regulate the rotation of the carrier. Also, with a carrier sensor 510, the carrier 102 establishes the position (home position) in the directions indicated by arrows a and b. A reference numeral 301 designates a recovery unit which comprises a cap 302 facing the discharging surface of the head cartridge 101 at a given position (a home position, for example) outside the recording area for the head cartridge 101, and a cap advance and retraction driver (not shown) to keep the cap in contact with the discharging surface to protect it when recording is at rest or the like occasions. Also, it is possible to arrange a pump to suck overly viscous ink, dust particles, and air bubbles from the discharging ports when the cap is in contact with the discharging surface in order to maintain the ink ejection conditions desirably, and a member to contain such an unwanted ink thus sucked.

Furthermore, a wiper (not shown) is provided to clean the vicinity of the discharging ports of the head cartridge 101.

A reference numeral 201 designates a feed roller to feed a recording medium 6 in the directions indicated by an arrow c in Fig. 7 and 202, a pinch roller to press the recording medium 6 against the feed roller 201. The recording medium 6 is fed intermittently in the directions indicated by an arrow c in Fig. 7 while being pinched by a pair of these rollers. The feed roller 201 is coupled to a feeding motor 402b through a transmission mechanism formed by a feed roller gear 205 and feed roller idler gear 206 so as to receive the transmission of the driving force. Also, pinch roller 202 is capable of being in contact with or apart from the feed roller 201 by the operation of a release lever

210.

A reference numeral 207 designates a platen to regulate the recording surface of the recording medium 6 to keep it flat. Also, it may be possible to provide a member to prevent the recording medium 6 from being raised by pressing it against the platen 207.

A reference numeral 213 designates a discharge roller which rotates in synchronism with the feed roller 201 to deliver the recording medium 6 after recording in the directions indicated by an arrow c in Fig. 7. There is provided a spur roller 214 at a position opposite to the discharge roller 213 through the recording medium 6. With those rollers, the recording medium 6 is delivered outside the printer after the recording is over.

As shown in Fig. 8, the recovery unit comprises a cap 4021 to cap the discharging surface 4002c of the recording head 4002a; a pump unit 4023 which makes the inside of the cap negatively pressurized to suck from the cap 4021 the waste ink forcibly exhausted from the discharging surface 4002c and forward it to a waste ink tube 4031d; and a transmission mechanism (timing gear) 4024 consisting of a known cam and gear mechanism to transmit driving forces to the foregoing cap 4021 for its forward and backward movement with respect to the discharging surface 4002c as well as for the driving of the foregoing pump unit 4023. To the aforesaid timing gear 4024, the rotational driving force of the carrier motor is transmitted through a carrier motor pinion 4020.

Also, the pump unit 4023 comprises a plunger pump shown in Fig. 9, in which a reference numeral 4031 designates a cylinder having a cylindrical cylinder portion 4031a and a guide member (not shown) which guides a plunger 4022 which will be described later. Then, it is partially cut off in the axial direction to provide an ink passage; 4031b, a cap lever receptacle formed to allow the lever seal which will be described later to be inserted. Also, a reference numeral 4031c designates an ink suction inlet which is opened to a given position; 4031d, a waste ink tube the integrally formed leading end of which is inserted into a waste ink absorbent 4028; also, 4031e, a cap open and close protrusion which is pressed by the cap open and close cam 4024a of the timing gear 4024 to cause the cylinder 4031 to rotate to open and close the cap 4021.

A reference numeral 4022 designates a plunger comprising a operation shaft 4022a, a piston stopper 4022b, a piston receptacle 4022c, and a pump seal stopper 4022d. Then, a groove 4022e which serves as an ink passage is continuously formed on the aforesaid operation shaft 4022a. This groove is partially inserted into the aforesaid guide of the cylinder 4031 to hold the rotation of the plunger 4022. On the operation shaft 4022a, a lead groove 4022f is formed to control the reciprocation of the plunger 4022. The protrusion (not shown) of a stroke gear 4005 is inserted into this lead groove 4022b. Then, by the normal and reverse rotations of the stroke gear 4005, a desired stroking amount is given to the plunger 4022 to generate the negative pressure.

A reference numeral 4032 designates a piston made of a rubber material such NBR. Its outer diameter is made larger than the inner diameter of the cylinder 4031 by a given amount, and it is appropriately compressed when inserted into the foregoing cylinder 4031; 4033, a pump seal made of a rubber material such as silicon rubber or NBR, which is inserted into the cylinder 4031. Its inner diameter is made slightly smaller to obtain a given pressure with respect to the plunger 4022 and, further, it can reciprocate in the cylinder 4031 by being pressed by the pump seal stopper 4022d of the plunger 4022 and the piston receptacle 4022c. Also, it may be possible to reduce the sliding friction between the cylinder 4031 and plunger 4022 by applying lubricant to the surface of the pump seal.

A reference numeral 4034 designates a cap lever. An ink guide (not shown) biases the cap lever seal which will be described later. The other rotational shaft 4034a is rotatively mounted to the hole 4031f of the cylinder 4031 by snap fitting, and 4035, a cap lever seal to which the ink guide of the aforesaid cap lever 4034 is inserted by compression. It is further inserted into the cap lever receptacle 4031b of the cylinder 4031.

A reference numeral 4021 designates a cap made of an annular chrolinated butyl rubber or some other resilient material having a triangular cross-section, and is mounted on the cap mounting unit 4034b of the foregoing cap lever 4034; also, 4042, a preliminary discharging pad which is made of a polymeric absorbent as the foregoing blade cleaner 4039. It is mounted on the foregoing cap lever 4034. The aforesaid preliminary discharging pad is an absorbent to absorb the ink preliminarily ejected aside from the ordinary ink ejection for a printing operation. This preliminary ink ejection is conducted to prevent ink on the discharging surface 4002c from being dried in the printing operation.

Subsequently, the description will be made of an information processing apparatus in which a recording apparatus embodying the present invention is incorporated. Its structure and electrical circuitry will be described.

Fig. 10A is a schematically perspective view illustrating the outer appearance of an information processing apparatus 604 wherein a recording apparatus embodying the present invention is incorporated.

In Fig. 10A, a reference numeral 601 designates the above-mentioned printing unit; 602, a key board provided with keys to input letters, numerals, and other characters as well as keys to give various instructions; and 603, an indication unit provided with

a display. Fig. 10B is a schematically perspective view illustrating the outer appearance of an information processing apparatus 604 wherein a recording apparatus embodying the present invention is incorporated. In Fig. 10B, a reference numeral 605 designates a window provided for replacing the foregoing recording head 1 and ink tank 2; 606, a cover for the window 605 to cover it except when the replacement operation is executed. The window 605 is made large enough to provide a head lever 601 and tank lever 605 to be operated when the recording head 1 or ink tank 2 is replaced. A reference numeral 607 designates a change over switch for the intended replacement of the recording head 1 or ink tank 2. When the change over switch 607 is turned on, a carrier motor 402a is driven to shift the carrier 102 to the window position 605 from the foregoing home position or the recording area. In this position, when the replacement of the recording heads 1 or ink tanks 2 is completed, the carrier 102 is shifted to its home position when a release switch 608 is turned on and then a recovery unit 301 is actuated to execute the ink suction and ejection, or wiping and other recovery operations. Thus, the current status returns to the operation before the change over switch 607 is turned on. Now, Fig. 11 is a block diagram showing the structure of electric circuits for an information processing apparatus according to the present embodiment.

In Fig. 11, a reference numeral 501 designates a controller to execute main controlling; 502, a CPU for a microcomputer mode to execute certain procedures, for example; 503, RAM for providing development and work areas for text data and image data; 504, ROM for storing programs corresponding to the aforesaid procedures; 505, a timer for the CPU 502 to work out execution cycles and for the printing unit 601 to work out the timing required when a recording operation is executed; and 506, an interface unit to connect signals from the CPU 502 to the peripheral apparatuses.

Also, a reference numeral 507 designates a controller for the printing unit 601; 508, a head driver to transmit recording signals and electric power to the head cartridge 101; 509a and 509b, motor drivers to transmit signals and electric power required to drive a carrier motor 402a and feed motor 402b, respectively; 510, a carrier sensor to detect the current position of the carrier 102 and determine whether the carrier 102 is currently at its home position or not, for example; and 511, a paper sensor to detect the presence of a recording medium 6 in order not to perform recording on any places other than the recording medium 6 when the recording medium 6 is yet to be inserted or a recording is terminated up to the end of a page.

Moreover, a reference numeral 605 designates an external storage such as FDD, HDD, or RAM card, and 512, an external interface to communicate with other information processing apparatuses, or to control peripheral apparatuses by making connection with inner buses.

In this respect, although not included in the block diagram shown in Fig. 11, an electric power source is provided to supply current to the above-mentioned electric circuits. For such an electric power source, there is available a rechargeable buttery, disposable dry cells, or AC power converter when the information processing apparatus body is fixed for use, for example.

With the above-mentioned structure of electric circuits, recordings are performed on the recording medium 6 by the recording unit. Now, using a flowchart shown in Fig. 12, the recording operation control sequence will be described briefly.

With an instruction to start recording by the use of the recording instruction key on an indication operation unit of a printer body or by an external instruction to start recording through the external interface, a series of procedures are started as follows:

At first, in step S1, whether the indication operation unit is in the on line status or not is determined. This is a precaution not to start any recording operation without a required preparation on the printer side when an external instruction to start recording operation is transmitted mainly by communications. Here, if the indication operation unit is determined to be in the on line status, the procedure will proceed to step S2.

In the step S2, whether the recording medium 6 is set on the printing unit or not is determined in accordance with signals from the paper sensor 511 and others. This is a precaution not to start printing because if any printing is started without a recording medium, ink is scattered in the printer to stain the apparatus itself particularly when an ink jet printer or the like is used as a recording apparatus, or the ink which is a recording medium is wastefully consumed.

Furthermore, in the step S2, it may be possible to determine whether the pinch roller 202 and feed roller 201 are released or not in addition to the detection of the presence of the recording medium. This is required to prevent any irregular feeding of the recording medium because when the pinch roller 202 is released, the normal feed is impossible even if the recording medium 210 is set. Whether the pinch roller 202 is release or not can be detected by means of a mechanical switch provided for the release lever or the like. Here, if it is found that the recording medium is not normally set, the procedure will proceed to the next step 3 .

In the step S3, a message is emitted to call the attention of an operator to set the recording medium. Such a message can be emitted by illuminating light in the indication operation unit or make a buzzer sound.

Also, in the step S3, if the recording medium 6 is

found to have been set, the procedure will proceed to step S4.

In the step, the recording is started. With the instruction from the CPU 502, the head driver 508 drives the head cartridge 101. Also, in synchronism therewith, the motor drivers 509a and 509b drive the carrier motor 402a and feed motor 402b, respectively, to perform the recording while allowing the carrier 102 to be shifted in the main scanning direction, the recording medium to be shifted in the sub-scanning direction, and the recording head 1 to be cleaned among others.

Lastly, in step S5, if an instruction to terminate the recording operation is given by the corresponding signal from the CPU 502, for example, or if it is determined that any more recording is possible when the number of recording lines in a page in a given sub-scanning direction has been reached or the terminating end of the recording area in a recording medium 6 is detected by the paper sensor 511, it is judged that the recording operation is terminated and that the recording operation procedures are completed.

In step S6, then, the carrier 102 is returned to its home position as a procedure to terminate the recording operation. This is carried out to cap the ink discharging surface of the recording head 1 for its protection in preparation for the power turn off after the termination of the recording operation. Then, if, for example, the feed motor 402b is driven for a given amount or the feed motor 402b is driven until when the paper sensor 510 detects and verifies that the recording medium 6 has been discharged. In this way, the recording medium is discharged. After that, the CPU 502 instructs the indication operation unit to display the termination of the recording operation or informs the peripheral apparatuses accordingly through the external interface; hence terminating the recording operation completely.

As described above, the recording head and ink tank are separable as in the present embodiment, and then, by arranging the structure of the ink jet recording apparatus such as to conduct the separating or integrating operation either in the on carrier condition or off carrier condition, the following effects can be obtained:

Since the ink tank is mounted on the carrier, any ink supply tube and the like are no longer needed. Thus, it is possible to fabricate the apparatus smaller.

Also, when ink is totally consumed, it will suffice only if the ink tank is replaced, not the cartridge which is integrated with the head. Therefore, it is possible to reduce the running cost significantly.

Also, if either one of the recording head and ink tank needs to be replaced, it is possible to replace only the one which must be replaced. Thus, the operational economy is improved.

Also, when the recording head and ink tank are separated on the carrier by the use of a lever or the like, it is possible to control the speed with which the separation is carried out; thus preventing ink to be scattered from the ink supply inlet 10 and ink supply outlet 11.

Also, when the recording head and ink tank are separated on the carrier, there is no need for holding the recording head by hand directly. Accordingly, there is no possibility that a hand touches the vicinity of nozzles of the recording head 1. It is thus possible to prevent any unwanted contamination that may produce adverse effects on printing.

Also, when the recording head and ink tank are separated on the carrier, the portion where force exerted by the ink tank 2 can be specified. Therefore, the structure can be arranged so that it is made strong enough only against such specific portion. Consequently, any other portions than this can be fabricated thin; thus enabling the tank to be made light in its weight while increasing its volume. Also, if ink colors should be replaced, the recording heads and ink tanks can be replaced as they are still in the coupled state. There is no possibility that ink colors are mixed. The replacement can also be carried out simply.

Fig. 13 is a plan view schematically showing another embodiment according to the present invention.

Fig. 13 is a plan view corresponding to the view of the foregoing embodiment shown in Fig. 1 observed from the above, in which a reference numeral 112 designates a head clamp lever to fix the recording head 1 to the carrier 102; 113, a head contact to connect the head electrially; and 114, an ink tank pressure lever which is interrelated with an ink tank lever 107 to execute the integration and separation of the ink tank 2. The head unit and carrier unit of the ink jet recording apparatus comprise each of these elements.

In the foregoing embodiment, the recording head 1 is pressed to the stopper 110 in the direction indicated by an arrow a in Fig. 6 to couple the recording head 1 and carrier 102 mechanically with the pressure exerted by the head fixing spring 108. The method for fixing the recording head is not confined thereto. It may be possible to adopt a method given below.

In other words, the head clamp lever 112 is structured with a rigid material to be able to rotate and move in parallel, not with a resilient material to press the object. Here, the description will be made of a method for fixing the recording head to the carrier 102. At first, the head clamp 112 is retracted to the position which is indicated by a broken line. Then, the recording head 1 itself or the recording head 1 and ink tank 2 which are in the integrated state are inserted in the direction indicated by an arrow a in Fig. 13 and shifted from such a state shown until the leading end of the recording head 1 is butted to the head contact 113. From this state, the head clamp lever 112 is shifted in the direction indicated by an arrow c in Fig. 13

while being rotated to arrive at the position which is indicated by a solid line and is fixed as it is.

In the head contact 113, a resilient pad 111 is pinched as described in conjunction with the foregoing embodiment. Therefore, the recording head 1 is pressed back in the direction indicated by an arrow b in Fig. 13, but due to the presence of the head clamp lever 112, it cannot be shifted but fixed there. At this juncture, by the force exerted to press it back, the contact pressure of the head contact 113 is secured. Also, the separation of the recording head 1 and carrier 102 can be performed in the operation contrary to the above, and withdrawn by shifting them in the direction indicated by an arrow b in Fig. 13.

In this respect, for the separation of the ink tank 2, the ink tank lever 107 (not shown) is operated to cause the ink tank pressure lever 114 to be shifted in the direction indicated by an arrow b in Fig. 13. With the above-mentioned structure, the following effects can be obtained:

When the separating operation for the ink tank 2 is executed in the on carrier condition, the force exerted on the recording head 1 is received by the head clamp lever 112. Therefore, the recording head 1 is not shifted; obtaining an enhanced reliability.

Also, when only the ink tank 2 is separated in the on carrier condition, or the recording head 1 and ink tank 2 are separated from the carrier 102 still in the coupled state, the shifting direction is as indicated by an arrow b in Fig. 13. Accordingly, the operativity is improved.

Fig. 14 is a plan view schematically showing a method according to another embodiment.

In Fig. 14, a reference numeral 115 designates a head pressure lever holding a head contact 113, which can rotate or move in parallel and 116, a head stopper fixed on the inner side of the carrier.

According to the present embodiment, the following procedures will be taken to fix the carrier 102 and recording head 1. The head fixing lever 115 which is rotatively fixed to the carrier 102 is rotated to the position indicated by a broken line in Fig. 14. Then, the recording head 1 itself or the coupled recording head 1 and ink tank 2 is inserted in the direction perpendicular to the plane of Fig. 14, so that the protrusion of the recording head 1 is placed between the head stopper 116 and head pressure lever 115. Then, the head fixing lever 115 is rotated to the position indicated by a solid line; hence fixing the head fixing lever 115 by a means which is not shown in Fig. 14. At this juncture, since a resilient pad 111 is used for the head contact 113 as in the case of the foregoing embodiment described in Fig. 13, the contact pressure is secured by the compressed resilience of the resilient material.

Also, the separation of the recording head 1 and carrier 102 can be performed by the operation contrary to the above, and withdrawn by shifting them in the direction perpendicular to the plane of Fig. 14.

In this respect, in order to separate the ink tank 2, the ink tank lever 107 (not shown) is operated to shift the ink tank pressure lever 114 in the direction indicated by an arrow b in Fig. 14. With the above-mentioned structure, the following effect can be obtained:

When the ink tank 2 separation is performed in the on carrier condition, the force exerted on the recording head 1 is received by the head stopper 116 so as not to cause the recording head 1 to be shifted; hence obtaining an improved reliability.

Figs. 15B, 15C, and Fig. 16 illustrate the ink passage coupling of the recording head and ink tank according to still another embodiment of the present invention. Fig. 15B shows the case where the ink supply outlet 11b is made of a resilient material such rubber, and it is possible to make the inner diameter of the ink supply outlet 11b smaller than the outer diameter of the ink supply inlet 10a; thus improving the contactness between the ink supply inlet 10a and ink supply outlet 11b when the recording head 1 and ink tank 2 are coupled. Accordingly, the sealing capabil,ity of the ink passage is also improved. Further, since a force required to deform the ink supply outlet 11b can be small, it is possible to make the force required to mount and demount the recording head 1 and ink tank 2 equally small.

Fig. 15C illustrates the case where the ink supply inlet 10c is made annular having an acute end while the ink supply outlet 11c is formed by a resilient material such as rubber without any hole. When separated from the recording head 1, the ink supply outlet 11c of the ink tank 2 is closed so as not to allow any ink leakage from the ink supply outlet 11c. Therefore, the ink tank 2 itself can be handled in an excellent condition. Also, when the ink tank 2 and recording head 1 should be coupled, the acute end of the ink supply inlet 10c made a hole in the ink supply outlet 11c to form an ink passage. Thus, a stabilized coupling of ink passages is possible, at the same time making the force required to connect or separate the ink tank 2 to or from the recording head small.

Fig. 16 illustrate the case where guides 10e and 11e are provided in the direction perpendicular to the direction of the ink passage. By shifting the ink tank 2 in the direction perpendicular to the plane of Fig. 16 with respect to the recording head 1, the coupling and separation are performed. Also, in the coupling portion, a sealing member 10f made of a resilient material such rubber is provided to prevent ink leakage. When the directions in which the recording head 1 are mounted or demounted are the same as the directions in which the ink tank 2 is mounted or demounted, the structure will be the same as the foregoing embodiment, but such directions are arranged as indicated by arrows a and b in Fig. 16, the mounting or demounting directions are different for the recording

head 1 and ink tank 2. As a result, the relationship associated with the forces as shown in Fig. 6 will be eliminated; thus making it possible to mount or demount the ink tank 2 and recording head 1 with a minimum force required.

Figs. 17A and 17B illustrate another embodiment according to the present invention wherein the mounting and demounting of the ink tank 2 are controlled. Fig. 17A shows the state where no recording head 1 nor the ink tank 2 is present, in which a reference numeral 151 designates a head detection lever rotating in response to the mounting or demounting of the recording head 1; 151a, a pinion transmitting the rotation of the head detection lever 151 to the rack 152a of a stopper 152; a tank control lever to control the installation of the ink tank 2. When neither the recording head 1 nor the ink tank 2 is present, both the head detection lever 151 and tank control lever 153 are arranged to block the installation passages of the ink tank 2 and recording head 1 by the biasing force exerted by springs or the like (not shown). Also, the stopper 152 is shifted by the head detection lever 151 to the position where it can regulate the rotation of the tank control lever 153 in the installation direction of the ink tank 2. In other words, when the recording head 1 is yet to be mounted, the installation of the ink tank 2 is blocked by the tank control lever 153. Fig. 17B illustrates the state where the recording head 1 is mounted. The head detection lever 151 is rotated due to the installation of the recording head 1 as shown in Fig. 17B. The rotation of the head detection lever 151 is transmitted to the stopper 152 through the pinion 151a to release the rotational regulation of the tank control lever 153 as shown in Fig. 17B. In other words, when the recording head 1 is mounted, the installation of the ink tank 2 becomes possible. As a result, the ink tank 2 can be attached to or detached from the recording head 1. Also, in a case where the arrangement is simple so that only the recording head 1 is mounted on or demounted from the carrier 102, the installation of the ink tank 2 is prohibited when the recording head 1 is yet to be mounted; hence preventing any erroneous operations.

Figs. 18A and 18B illustrate still another embodiment according to the present invention wherein the mounting and demounting of the recording head 1 are controlled. Fig. 18A shows the state where both the recording head 1 and ink tank 2 are installed. The structure is the same as Fig. 4, but there is a tank detection lever 160 provided beneath the lower part of the ink tank mounting unit of the carrier 102. The contacting portion 160a of the tank detection lever 160 is regulated by the ink tank 2 to set its position while the hook 160b of the ink detection lever 160 is released from the cut off portion 106a of the head lever 106. Thus, the head lever 106 is rotative. When the head lever 106 is rotated in the direction indicated by an arrow at a, the recording head 1 and ink tank 2 are shifted in the direction indicated by an arrow at b as they are still in the coupled condition as in the case shown in Fig. 4. Hence, it becomes possible to remove them. Fig. 18B shows the state where the recording head 1 is mounted while the ink tank 2 is yet to be mounted. The tank detection lever 160 is biased by biasing means (not shown) such as a spring in the direction indicated by an arrow at d When the ink tank 2 is not present, the lever is rotated as it is in the state shown in Fig. 18B. Then, the hook 160b engages with the cut off portion 106a to regulate the rotation of the head lever 106. In other words, it becomes impossible to remove the recording head 1 if no ink tank 2 is present. As a result, it becomes impossible to handle the recording head 1 itself. Thus, there is no possibility that a hand touches the vicinity of the ink ejection nozzles of the recording head 1 or the vicinity of the ink supply inlet 10. Any contamination which may produce adverse effects on recording can be prevented assuredly. Also, any adverse effect that may affect the recordings attributable to the fact that the recording head 1 is handled as a single body can be eliminated assuredly because there is no possibility that air is taken from the ink ejection nozzles and the ink supply inlet 10 to be mixed in the ink passages.

In the foregoing embodiment described in Fig. 1, the presence of the recording head 1 on the carrier 102 can be detected by discriminating whether the recording head 1 is electrically connected or not. However, it does not have any means to detect the remaining quantity of ink in the ink tank 2 or to transmit to an information processing apparatus the information regarding the presence of the ink tank 2 on the carrier 102. The present invention is not confined to this, and it may be possible to provide the above-mentioned detecting means.

Fig. 19 is a block diagram showing the electric circuits of an information processing apparatus according to still another embodiment of the present invention.

In Fig. 19, a reference numeral 513 designates an ink tank sensor to detect whether the ink tank 2 is present on the carrier 102 or not, and 514 , an ink remain sensor to detect the presence of printable ink in the ink tank 2. The description of any elements having the same reference numerals as those in Fig. 11 will be omitted.

More specifically, the ink tank sensor 513 may be such that mechanical contacts are arranged on the carrier 102, or a structure is arranged so as to provide an optical sensor for the purpose. The ink remain sensor 514 may be arranged in such a manner that by making the ink tank 2 with a transparent material so as to allow the remaining quantity to be detected optically from outside, or a sensor is provided in the ink tank 2 to sense the liquid therein and contacts are arranged on the surface of the ink tank connecting to such a sensor; thus arranging the contacts on the

carrier 102.

With the above-mentioned sensors, it is possible to transmit to the CPU 502 information through the interface 506 to issue warning or execute appropriate processes when a recording operation is intended without the presence of ink tank 2 or recording head 1, or the related printing becomes disabled due to the shortage of the remaining ink during the recording operation.

For example, there is a possibility that the recording operation becomes disabled immediately after the ink tank 2 is connected to the recording head 1 because of air bubbles mixed in the recording head 1. In order to prevent this, it may be possible to arrange the system to interpret such a change in the status that while the recording head 1 is on the carrier 102, the ink tank 2 which is absent is now present as a case where an ink tank 2 is newly connected to the recording head in the on carrier condition, and to allow the carrier 102 to return to its home position for the suction operation by the recovery unit 301.

With the above-mentioned structure, the following effects can be obtained.

While in printing, if ink is totally consumed, the operation is automatically suspended and a warning is given accordingly. Thus, no recording medium will be wasted.

Also, after the replacement of ink tanks, there is no need for executing the recovery operation manually. Therefore, operativity will be improved.

Each of the embodiments set forth below can be preferably used for the foregoing ink jet recording apparatus. Hereinafter, as another embodiment, the description will be made of an embodiment wherein a recording head and an ink tank are separable and replaceable, and the recording head is coupled by pressing it to the carriage which carriers the recording head in a given direction.

Fig. 23 is a cross-sectional view showing the state where a recording head, ink tank, and carriage are coupled in an ink jet recording apparatus according to another embodiment of the present invention.

In the present embodiment, a recording head 1010a is of a type which is used for an ink jet method using electrothermal transducers to generate thermal energy to give film boiling to ink in accordance with electric signals.

In Fig. 23, the principle structure of the recording head 1010a is such that all the elements are laminated by adhesion or pressing on a head base plate 1011a with the positioning protrusions 1011a-1 and 1011a-2 arranged on the head base plate 1011a as positioning reference.

Here, in the vertical direction in the inner face in Fig. 23 is positioned by the reference face 1104a-1 of a front board 1101a and a protrusion 1011a-1, while the horizontal direction in the inner face of Fig. 23 is positioned by a head positioning unit 1104a and a protrusion 1011a-2. Further, the direction perpendicular to the cross-section of Fig. 23 is positioned by the protruded portion (not shown) of the protrusion 1011a-2 which is protruded partially to cover the head positioning unit 1104a, and the head positioning unit 1104a.

On a heater board 1013a-2, there are formed by film deposition on an Si substrate, electrothermal transducers (ejection heaters) arranged in plural arrays and electric lines of aluminum and others to supply electric power. The heater board is connected to a head flexible board (hereinafter referred to as head PCB) 1013a having lines with pads 1013a-1 arranged at its leading ends to receive electric signals from the apparatus body. The connection is made by wire bonding with each of the corresponding lines arranged face to face. Then, the ink ejection unit is formed with a common liquid chamber inducing ink from a replaceable ink tank 1001a through partition walls to partition each of the plural ink passages in accordance with the ejection heaters and liquid passages in order to supply it to ink passages, and a grooved ceiling board 1012a, which is integrally formed with orifices constituting a plurality of discharging ports by polysulfone or the like, is pressed by a spring (not shown) to the heater board 1013a-2, at the same time being fixed by pressing with adhesives and sealed; thus fabricating the ink discharging unit. The liquid passages 1015a coupled to the grooved ceiling 1012a and sealed can be connected to the replaceable ink tank 1001a in the present embodiment. To this end, the liquid passages are penetrated through to the opposite side of the head base plate 1011a through the hole provided for the head PCB 1013a and head base plate 1011a, at the same time being fixed adhesively to the head base plate 1011a.

Also, at the end of the coupling side between the liquid passage 1015a and ink tank 1001a, a filter 1008a is provided to prevent dust particles and unwanted air bubbles from flowing into the discharging ports. Also, a head cover 1018a is provided to protect the discharging ports of the recording head 1010a and the pad 1013a-1 for electrical connection as well as to make it easier to hold the recording head 1010a from its handling end.

The replaceable ink tank 1001a has, in its tank case 1001a-1 having ribs 1001a-2 on its inner face, the ink absorbents 1002a retaining ink stuffed with almost no space, the ink supply outlet (hole) 1004a to which the leading end of the liquid passage 1015a with the filter 1008a provided at its leading end is inserted to make ink connection, and the air conduit 1003a (hole) to prevent a negative pressure from being generated excessively by introducing air into the replaceable ink tank 1001a in an amount corresponding to ink flowing out from the replaceable ink tank 1001a. On the inner wall of the tank case 1001a-1, the ribs 1001a-2 are provided in order to prevent di-

rect air conduction to the ink supply outlet 1004a through the inner wall of the tank case 1001a-1 for the maximum utilization of ink in the total area of the ink absorbents 1002a by the force exerted by the capillary phenomenon and at the same time, the air conduit 1003a is arranged away form the ink supply outlet 1004a as far as possible. The ribs 1001a-2 function to reinforce the tank case 1001a-2 simultaneously so as to contribute to improving the operativity when tanks are replaced. The initial amount of ink retained in the ink absorbents 1002a is less than the total absorbable amount of the ink absorbents 1002a in order to give a negative water head pressure to the meniscus of the discharging ports of the recording head 1010a when it is coupled for the functional purpose to enable a stabilized ejection as well as for the operational purpose to prevent any ink leakage even when a slight shock is given at the time of replacing ink tanks. It may be possible to control ink leakage from the air conduit 1003a by arranging the provision of a liquid repellent treatment for the ink absorbent 1002a in the air conduit 1003a or using a separate liquid repellent absorbent. The ink supply to the replaceable ink tank 1001a comes to a limit when the retained ink in the ink absorbent 1002a becomes extremely small to make the ink suction of the ink absorbent 1002a greater than the ink supply capability to the recording head 1010a by the force exerted by the capillary phenomenon of the nozzles following the ink ejection or when the air induced from the air conduit 1003a becomes great around the filter 1008a and the air is supplied to the ink absorbent 1002a in a large amount through the air filter 1008a.

The mechanical and electrical connection of the recording head 1010a and replaceable ink tank 1001a to the carrier HC are conducted in the following manner.

For the carriage HC, there are provided a front board 1101a positioned on the platen side (the front side of the head); a flexible sheet 1102a-1 provided with the head driving electrode 1102a corresponding to the pad 1013a-1 on the head PCB of the recording head 1010a; an electrical contact supporting board 1100a which a resilient member (rubber pad) 1102a-2 pressing the flexible sheet from its rear side; a head positioning unit 1104a to fix the recording head 1010a mechanically; and a pressing hook 1103a to support the recording head 1010a with one-way biasing. Here, two front boards 1101a are arranged each for the foregoing positioning protrusions 1011a-1 and 1011a-2 providing the positioning reference surface 1104a-1 for the head base plate 1011a of the recording head 1010a. The pressure hook 1103a of the carraige HC is structured to exert a biasing force in the direction indicated by a broken arrow in Fig. 23, that is, inclined approximately at ten degrees in the traveling direction of the carriage HC. Therefore, due to such a biasing force, the recording head 1010a is pressed in both directions toward the front board 1101a and the electric connection supporting board 1100a. At the same time, it is biased in the traveling direction of the carriage HC in the head positioning unit 1104a with the electric connection supporting board 1100a as its pivot. Although this pressure coupling operation of the pressure hook 1103a can be executed anyway, it is preferable to do it by a lever or the like from the upper surface side of the carriage HC. In any way, when this pressure hook 1103a is coupled, the recording head 1010a and replaceable ink tank 1001a are electrically connected after being slightly rotated on the carrier HC to allow the positioning protrusions 1011a-1 and 1011a-2 to be in contact with the positioning reference surface 1104a-1 of the front board 1101a. Thus, the positioning of the pad 1013a-1 on the head PCB 1013a and head driving electrode 1102 is also reliably executed.

Before the recording head 1010a and replaceable ink tank 1001a are coupled, the carriage HC and recording head 1010a, and the recording head 1010a and replaceable ink tank 1001a are separated as shown in Fig. 24. Only the respective coupling portions are in contact. The recording head 1010a and replaceable ink tank 1001a begin to be coupled with the engagement between the coupling hook 1017a provided on the head base plate 1010a and coupling guide 1005a provided on the replaceable ink tank 1001a as shown in Fig. 24. To arrange this coupling portion between the ink supply outlet 1004a and head positioning unit 1104a makes it possible to connect ink supply passages reliably when the replaceable ink tank is coupled to the recording head 1010a.

In other words, as clear from Fig. 24, when the replaceable ink tank 1001a is rotated in clockwise direction in Fig. 24, the ink supply outlet 1004a becomes the actuating point with the coupling portion between the coupling hook 1017a and coupling guide 1005a as its pivot if a thought is given as to the coupling of the recording head 1010a and replaceable ink tank 1001a. Therefore, the liquid passage end are coupled with the ink absorbent 1002a and filter 1008a as coupling faces. Further, at the same time, a resilient ring seal 1009a pinched between the head base plate 1011a and the outer wall of the replaceable ink tank is pressed and deformed to be tightly in contact with them. Thus, the conduction between the interior of the replaceable ink tank 1001a and the atmosphere is completely blocked in the ink supply outlet 1004a. If this sealing is insufficient, the air induction to the interior of the replaceable ink tank 1001a following the ink supply to the recording head 1010a occurs directly without any intervention of the ink absorbent 1002a. As a result, it becomes difficult to effectively utilizes ink retained in the ink absorbent 1002a. The pressure hook 1103a is established to pr,vide its pressure in the direction inclined at ten degrees in order to position the recording head 1010a in the direction

toward the plane of Fig. 24 with respect to the carriage HC as described earlier. Therefore, also, in consideration of the coupling to the recording head 1010a, a force is exerted in the direction orthogonal to the coupling direction.

Now, given the force in the pressure direction as F and the contacting force between the pad 1013a-1 on the head PCB 1013a of the recording head 1010a and the head driving electrode 1102a on the flexible sheet 1102a-1 through the rubber pad 1102a-2 on the electrical connection supporting board 1100a as F_1, the following relationship is obtainable:

$$F_1 = F\cos 10°$$

On the other hand, given the contacting pressure between the positioning protrusion 1011a-1 of the head base plate 1011a of the recording head 1010a and the positioning reference surface 1104a-1 of the front board 1101a of the carriage as F_2, the following relationship is obtainable:

$$F_2 = F\sin 10°$$

This force F_1 which effectuates the electrical connection is a component in the direction toward the plane of the head driving electrode when the pressure hook 1103a is inclined at ten degrees to the plane perpendicular to the head driving electrode plane with respect to the pressure guide 1011a-3 which is a part of the head base plate 1011a of the recording head 1010a. However, it effectuates the recording head 1010a directly without intervention of any other members such as the replaceable ink tank 1001a. Therefore, it is possible to obtain an optimally effective force F_1 assuredly; hence enabling the provision of a recording apparatus having an extremely high reliability in its electrical connection in terms of environmental and distributional aspects.

On the other hand, it is implemented by the application of the contact force F_2 to obtain the position where the carriage HC is opposed to the surface of a recording medium. The recording quality depends greatly on the positional relationship between the carriage HC and recording head 1010a. If such a position is not appropriate, the recording is slanted or the ruled lines represent a saw tooth configuration. In a worst case, the electrical connection is displaced to cause defective contacts, which generates missing dots.

In the present embodiment, the positioning contact pressure F_2 directly effectautes the pressure guide 1011a-3 which is a part of the head base plate 1011a of the recording head 1010a without the intervention of any other members. Its effective force is not attenuated and thus an optimal contact force F_2 can be obtained. In this way, a significant improvement is made for the accuracy of the distance between the recording medium and recording head, which is one of the major factors to affect the recording quality of an ink jet recording apparatus.

Moreover, since the F_1 force effectuates the pressure guide with the electrical connection as its pivot, a moment is generated on the recording head 1010a with the electrical connect as its pivot. Therefore, a contact force is given by the foregoing moment to the positioning protrusion 1011a-2 which is a part of the head base plate 1011a of the recording head 1010a, and the head positioning unit 1104a on the front board 1101a of the carriage HC without the intervention of any other members. As a result, the positioning accuracy of the recording head 1010a in the printing direction is significantly improved.

As described above, by directly passing the recording head 1010a, the electric power is assuredly supplied from the recording apparatus to the recording head 1010a, at the same time enabling the positioning accuracy to be significantly improved for the carriage HC and recording head 1010a. Hence, it is possible to obtain an ink jet recording apparatus having a high reliability and desirable recording quality.

Subsequently, the description will be made of another embodiment with reference to Figs. 26 to 29.

Although the fundamental structures of the recording head 1010b and replaceable ink tank 1001b are the same as the embodiment described in Fig. 23, this embodiment is different in the direction of pressing force for coupling the recording head 1010b to the carriage HC as well as the direction in which the replaceable ink tank 1001b is installed.

In other words, as shown in Fig. 26, there is no front board positioned in the platen side (front side of the head). A side board 1900 of the carriage HC is provided in the direction perpendicular to the platen instead. On this, the electrical connection is arranged as in the embodiment described in Fig. 23. In the two locations in the substantial center of both ends of the head base plate 1011b of the recording head 1010b, pressure guides 1901 are provided. To the pressure guides 1901, the side board 1900 of the carriage HC is pressed by the pressure hook 1908 shown in Fig. 29. Thus, it becomes possible to supply power from the recording apparatus to the recording head 1010b. In this case, too, the pressing force is directly given to the recording head 1010b vertically without the intervention of any other members. Thus, an optimal pressure force can be obtained assuredly. Hence, it is possible to obtain a recording apparatus having an extremely high reliability in its electrical connection in terms of environmental and distributional aspects.

Also, the protrusion 1902 which a part of the base plate 1011b of the recording head 1010b and the carriage positioning unit 1903 are butted so as to enable the pressing force to the carriage HC to be given directly from the recording head 1010b. Consequently, the positioning accuracy of the recording head 1010b in the recording direction is significantly improved.

In this respect, it may be possible to couple the replaceable ink tank 1001b to the recording head

1010b after the recording head 1010b has been coupled to the carriage HC or to couple the recording head 1010b to the replaceable ink tank 1001b before the recording head 1010b is installed on the carriage HC.

Fig. 27 shows the state where the recording head 1010b and replaceable ink tank 1001b are separated. Also, Fig. 28 shows the state where the recording head 1010b and replaceable ink tank 1001b are coupled.

Fig. 29 is a partially cross-sectional view observed in the direction indicated by a blank arrow A shown in Fig. 26, in which a reference numeral 1906 designates the portion where the recording head 1010b and replaceable ink tank 1001b are coupled. On the side board 1900 of the carriage, a dowel 1907 is provided, the pressure hook 1908 is rotated with this dowel 1907 as its pivot. At the leading end 1908a of the pressure hook 1908, the nail is provided to hold the pressure guide 1901 which is integrated with the base head base plate of the recording head 1904. Also, the dowel 1907 and pressure hook dowel 1909 are tensioned by a tensioning coil spring 1911. In this way, the recording head 1010b is electrically connected to the carriage HC through its side board 1900 reliably. These recording head amounting pressure hooks 1908 are also provided beneath the recording head 1010b. Thus, the recording head 1010b is stably pressed to the carriage side board 1900 from above and below as well.

In this respect, a reference numeral 1910 designates nozzles ejecting ink; 1908b, a lever to be used when the recording head 1010b is removed from the carriage HC. By pinching the two places thereof, the leading end 1908a of the pressure hook 1908 is released from the pressure guide 1901 of the recording head 1010b; thus enabling the recording head 1010b to be demounted from the carriage.

Subsequently, as another embodiment, the description will be made of an embodiment wherein an ink tank and recording head can be separated while the foregoing ink tank and recording head are mounted by separate means, respectively.

An ink tank 2001a is inserted into a carriage HC in the direction perpendicular to the plane of Fig. 30 in the state where it is coupled to a recording head 2010a. At this juncture, the replaceable ink tank 2001a is installed in a given location in the carriage HC by being guided by a replaceable ink tank front guide 2907a and replaceable ink tank rear guide 2908a on the carriage HC. Then, the replaceable ink tank 2901a is regulated by the snapping function of a pair of tank pressing front nails 2909a and 2911a and that of tank pressing rear nails 2910a and 2912a. Fig. 31 is a partially sectional view illustrating this viewed from the ink discharging surface side. The liquid passage 2913a extending from the recording head 2010a penetrates the bottom of the replaceable ink tank 2001a to the ink absorbent 2002a in the replaceable ink tank 2001a.

Here, in order not to allow dust particles and other impurities to be mixed in the recording head 2010a, a filter 2914a is provided and also, a ring seal 2915a is provided around the liquid passage 2913a to prevent ink leakage from the portion where the recording head 2010a and replaceable ink tank 2001a are coupled.

A member which connect the ink tank and recording head, that is, an ink absorbent 2002a with which a liquid passage 2913a is in contact under pressure, is of a sponge type. Also, the ring seal 2915a is made of a resilient material having a low hardness. Therefore, no compulsory force is exerted by the ink tank 2001a against the recording head 2010a. In this respect, a reference numeral 2916a designates nozzles. Fig. 32 is a cross-sectional view taken along line A - A in Fig. 30 to illustrate the replaceable ink tank itself. When it is mounted on the recording head 2010a, a supply unit seal 2004a-1 and conduit unit seal 2003a-1 are removed in the direction indicated by arrows, respectively.

Now, the description will be made of still another embodiment with reference to Fig. 33 to Fig. 35.

In the present embodiment, the fundamental structures of a recording head 2010b and replaceable ink tank 2001b are the same as the foregoing embodiment described in Fig. 30. What differs is the direction in which pressure is given when the recording head 2010b is coupled to the carriage HC and also the direction in which the replaceable ink tank 2001b is installed.

In other words, as shown in Fig. 33, there is no front board positioned on the platen side (front side of the head). A side board 2900b of the carriage HC is provided in the direction perpendicular to the platen instead. On this, the same electrical connection unit as the foregoing embodiment described in Fig. 30 are arranged. In two locations in the substantial center of both ends of the head base plate 2011b of the recording head 2010b, pressure guides 2901b are arranged. These pressure guides 2901b are pressed to the side board 2900b of the carriage HC by the pressure hooks 2908b shown in Fig. 35. Thus, it becomes possible to supply power from the recording apparatus to the recording head 2010b. Here, the pressure is exerted directly on the recording head 2010b vertically without the intervention of any other members. As a result, an optimal pressure is obtained reliably. It is thus possible to obtain a recording apparatus having an extremely high reliability in its electrical connection in terms of environmental and distributional aspects.

Also, the protrusion 2902b which is a part of the head base plate 2011b of the recording head 2010b and the carriage positioning unit 2903b are butted to enable a direct effect of the pressure from the record-

ing head 2010b to the carriage HC. The positional accuracy of the recording head 2010b in the recording direction can be significantly improved.

In this respect, the replaceable ink tank 2001b is coupled to the recording head 2010b after the recording head 2010b is mounted on the carriage HC.

Fig. 34 illustrates the state where the recording head and replaceable ink tank are separated.

Fig. 35 is a partially cross-sectional view illustrating the recording head and tank viewed in the direction indicated by a blank arrow B in Fig. 33, in which dowels 2907b are arranged on the side board 2900b of the carriage HC, and the pressure hooks 2908b are rotated with the dowels 2907b as pivot, respectively. At the leading ends 2908b-1 of the pressure hooks 2908b, nails are arranged to hold the pressure guides 2901b which are integrally formed with the head base plate 2011b of the recording head 2010b. Also, the dowels 2907b arranged on the side board 2900b and the pressure hook dowels 2909b are tentioned by tensioning spring coils 2911b, respectively. Hence, the recording head 2010b is electrically connected assuredly to the carriage HC on the side board 2900b. These recording head mounting pressure hooks 2908b are also provided beneath the recording head 2010b to press the recording head 2010b to the side board 2900b of the carriage from above and below stably.

In this respect, a reference numeral 2910b designate discharging ports (may be referred to nozzles in some cases) which eject ink, and 2908b-2, a notch used when the recording head 2010b is to be removed from the carriage. By pinching two parts of the notch, the leading ends 2908b-1 of the pressure hooks 2908b are released from the pressure guides 2901b of the recording head 2010b. Thus, the recording head 2010b is detached from the carriage HC.

Figs. 33 and 35 are views illustrating the replaceable ink tank 2001b installed in the horizontal direction as in Fig. 34 when the entire status is such as described above. The replaceable ink tank 2001b is installed in the horizontal direction against the pressure exerted by a pair of tank side end nails 2912b and 2913b. Accordingly, when it is butted against a pair of carriage stoppers 2914b and 2915b, the tank side end nails 2912b and 2913b are restored to complete the installation of the replaceable ink tank 2001b thereby to fit it there. Also, the carriage front nail 2916b and carriage rear nail 2917b are those which prevent the replaceable ink tank 2001b from being detached upward.

Here, at the same time that the replaceable ink tank 2001b is mounted on the carriage, a resilient ring seal 2009b provided in the portion 2906b where the recording head 2010b and replaceable ink tank 2001b are coupled is deformed to connect them. As a result, no ink leakage will take place. Also, since the coupling portion is flexibly structured using resilient material, no compulsory force is exerted on the recording head 2010b when the replaceable ink tank 2001b is mounted on the carriage. There is no possibility that the positioning accuracy of the recording head 2010b to the carriage is not lowered.

Fig. 36 is a schematically perspective view illustrating the recording head and ink tank of an ink jet recording apparatus according to another embodiment. In Fig. 36, a reference numeral 3001 designates a recording head ejecting ink in accordance with electric signals; 3002, an ink tank (ink cartridge) containing ink to be supplied to the recording head 3001; 3010, an ink supply inlet (liquid passage connecting unit) which serves as a passage for supplying ink from the ink tank 3002 to the recording head 3001; 3011, an ink supply outlet (liquid passage connecting unit) to supply ink from the ink tank 3002 to the recording head 3001; 3012, coupling nails which guide and hold the recording head 3001 and ink tank 3002 when both of them are integrated; 3013a and 3013b, coupling nail guide grooves to engage with the coupling nails 3012; 3016, a plurality of tank inner walls to partition the interior of the ink tnak 3002 into small chambers; and 3017, conductive holes opened on the tank inner walls 3016. With these elements, the head cartridge 3101 is structured.

Fig. 37 is a schematically perspective view illustrating the state where the head cartridge 3101 shown in Fig. 36 is mounted on the carrier unit. In Fig. 37, a reference numeral 3102 designates a carrier (mounting unit) provided for a recording apparatus body which holds the recording head 3001 and ink tank 3002; 3106, a head lever to hold or release the recording head 3001; 3107, an ink tank lever to mount or demount the ink tank 3002; and 3108, a head fixing spring to fix the recording head 3001 to the carrier 3102. With these elements, the head unit and carrier unit of the recording apparatus are structured.

The above-mentioned recording head 3001 comprises a plurality of electrothermal transducers which generate thermal energy to be utilized for ejecting ink, and a substrate on which a driving circuit is formed to drive these transducers; discharging ports and liquid passages arranged on the substrate corresponding to each of the above-mentioned plural electrothermal transducers; and further, a laminated ceiling board constituting a common liquid chamber conductively connected to each of the liquid passages. Then, the recording head 3001 thus structured is mounted on the apparatus in such a manner that the discharging surface where the discharging ports are arranged is placed to face a recording medium. In the head cartridge 3101 shown in Fig. 36, the structure is arranges so that ink is ejected in the direction indicated by an arrow a.

The ink tank 3002 is arranged to refill ink consumed by recording while holding ink and supplies ink to the recording head 3001 appropriately. When this

ink tank 3002 is present as a single body, the ink supply outlet 3011 is sealed with sealing means (not shown) so as not to allow any ink leakage. This sealing means is automatically or manually released when the ink tank is integrated with the recording head 3001 to make ink supply possible. Also, it may be possible to arrange a mechanism to induce air from the outside as the ink volume is being decreased by the ink consumption. Furthermore, the structure may be made to arrange a mechanism inside so as to maintain the pressure of ink to be supplied to the recording head 3001 slightly negative; thus making it possible to improve the printing quality as well as to prevent any ink leakage.

Also, the recording head 3001 and ink tank 3002 are used for the apparatus in a recording operation as a head cartridge 3101 wherein both of them are integrated. Now, the description will be made of a method for integrating both of them.

Fundamentally, the recording head 3001 and ink tank 3002 are integrated by coupling the ink supply inlet 3010 and ink supply outlet 3011. Therefore, this portion is carefully arranged to prevent ink leakage from or air intake into the ink passages. In the present invention, as shown in Fig. 38, a method is adopted to utilize the resiliency of a mold member for the purpose. In other words, the ink supply inlet hole 3010a and the ink supply outlet hole 3011a are formed cylindrically and then the inner diameter of the ink supply outlet 3011a is slight smaller than the outer diameter of the ink supply inlet hole 3010a. Thus, when the ink supply inlet hole 3010a is pressed into the ink supply outlet hole 3011a, these two holes are tightly integrated while being slightly deformed in the radial direction. Also, the coupling portion is not necessarily of a mold member, but it will suffice only if the material has a sealing capability. The other coupling methods will be described later.

In the integration of the recording head 3001 and ink tank 3002, while it is good enough to couple the ink supply inlet 3010 and ink supply outlet 3011 as described above, the coupling is intensified in the present embodiment by providing the coupling nails 3012 and coupling nail guiding grooves 3013a in order to prevent them from being disengaged simply due to any unexpected force that may be exerted when the head cartridge 3101 is handled or to facilitate the integration. In other words, the coupling nails 3012 formed integrally with the ink supply inlet 3010 by molding and capable of being resiliently deformed are provided with protrusions at the leading ends, and are fitted into the coupling nails guiding grooves 3013a while being resiliently deformed by the portions corresponding to the height of the protrusions. The coupling is completed when the protrusions of the coupling nails 3012 reach the deepest portions arranged in the rear sides of the coupling nail guiding grooves 3013a.

Further, the coupling nails 3012 serve as guides so as to allow the ink supply inlet 3010 and ink supply outlet 3011 to be easily joined when the recording head 3001 and ink tank 3002 are coupled. In other words, the coupling nails 3012 are made longer than the ink supply inlet 3010 so that the coupling nails 3012 are to be in contact with the ink tank 3002 before the ink supply inlet 3010 reaches the ink supply outlet 3011. Here, the leading ends of the coupling nails 3012 are cut off diagonally. This diagonally cut off portion serves as its guide in the direction indicated by an arrow b in Fig. 36 to facilitate the engagement with the nail guiding grooves 3013d. Also, the protrusions provided at the leading ends of the coupling nails 3012 are also cut off diagonally to promote an easier engagement by serving as its guide in the direction indicated by an arrow c in Fig. 36.

In this respect, while the coupling nails 3012 are provided on the recording head 3001 side, its position is not confined thereto. It may be possible to position them on the ink tank 3002 side or on both sides of the recording head 3001 and ink tank 3002.

Here, in the above-mentioned embodiment, the interior of the ink tank 3002 is separated into several small chambers by the inner walls 3016. The structure is arranged so that the small chambers themselves are connected through conductive holes 3017 provided in the vicinity of the bottom end of the inner walls 3016 of the ink tank 3002. In this case, some of the conductive holes 3017 must be filled with ink. Accordingly, it is necessary for the ink tank 3002 to have the end where the conductive holes 3017 are arranged at its bottom with respect to gravity (in the direction in which it is located in Fig. 36).

Therefore, if it is required to rotate the ink ejection direction a from the downward direction as shown in Fig. 36 to the direction indicated by an arrow d in Fig. 36, or to use the recording head for an apparatus wherein the advancing direction of its recording medium (not shown) is vertical and not horizontal, for example, or to place a recording apparatus itself vertically or horizontally for its use, the ink tank 3002 which is rotated together with the ink cartridge 3101 cannot satisfy the foregoing conditions, thus disabling its ink supply. In the present embodiment, therefore, a second coupling direction which is rotated approximately 90 degrees is arranged in addition to a first direction wherein the coupling nails 3012 and coupling nail guiding grooves 3013a are engaged. For this second coupling direction, the coupling nails 3012 are used in the same manner, but the coupling nail guiding groove 3013 engages with the other coupling nail guiding groove 3013b. The coupling method in this case is the same as the one used for the coupling in the first direction.

Also, since the positional relationship between the coupling nails 3012 and coupling nail guiding grooves 3013 is symmetrical in rotation with respect

to the ink supply inlet 3010, the coupling is possible in a total of four directions, that is, two more directions at 90 degrees each further from the above-mentioned second coupling direction.

Fig. 39 illustrates another embodiment to show the portion where the ink passages of the recording head 3001 and ink tank 3002 are coupled. Fig. 39A represents a case where the ink supply outlet 3011b is made of a resilient material such as rubber. Here, it is possible to make the inner diameter of the ink supply outlet 3011b smaller than the outer diameter of the ink supply inlet 3010b. Thus, the contactness between the ink supply inlet 3010b and ink supply outlet 3011b is improved when the recording head 3001 and ink tank 3002 are coupled. As a result, the sealing capability of the ink passages is enhanced. Also, a force required to deform the ink supply outlet 3011b can be small. The force required to effectuate the attachment and detachment of the recording head 3001 and ink tank 3002 can also be small.

Also, Fig. 39B illustrates a case where the ink supply inlet 3010c is formed to be annular having an acute end, while the ink supply outlet 3011c is made of a resilient material such as rubber having no holes. When separated from the recording head 3001, the ink supply unit 3011c of the ink tank 3002 is in a blocked state. Therefore, there is no ink leakage from the ink supply unit 3011c. The ink tank 3002 can be handled excellently as a single body. Also, when the ink tank 3002 is coupled to the recording head 3001, the acute end of the ink supply inlet 3010c makes a hole in the ink supply outlet 3011c to provide an ink passage. The liquid passages can be coupled stably. A force required to attach or detach the ink tank 3002 can also be small.

In the other embodiment described in Fig. 36, the mounting direction of the ink tank 3002 is of such a type that it is different only by the difference in angle in the axial direction, but irrespective of this, it may be possible to provide ink passages in a different position. Fig. 40 is a view schematically showing still another embodiment structured such as this to illustrate the direction in which the recording head 3001 and ink tank 3002 are coupled. In Fig. 40, a reference numeral 3018 designates a first ink supply inlet provided for the recording head 3001, and 3019, a second ink supply inlet arranged in a direction different from the first ink supply inlet 3018. A head cartridge 3101 comprises each of these elements. Here, the ink ejecting direction of the recording head 3001 is the one indicated by an arrow Bk in Fig. 40. As ink supply inlets to supply ink to the recording head 3001, the first ink supply inlet 3018 and second ink supply inlet 3019 are opened at angles of approximately 90 degrees to each other. These inlets are sealed if no ink supply outlets 3011 of the ink tank 3002 are installed. By a mechanism (not shown), these are released only when the ink supply outlet 3011 is mounted to form an ink passage. Therefore, when the ink tank 3002 is attached to either one of them, the other one is closed, and no air is mixed in the ink passage. Also, when the ink tanks are attached to both of them, ink can flow smoothly.

In this respect, unlike the embodiment described in Fig. 36, it is possible to use an ink tank which can supply ink without being affected by gravity as the ink tank 3002. Hence, in the present embodiment, it is also possible to attach the ink tank 3002 to the second ink supply inlet 3019 in the direction indicated by an arrow a. Also, the ink tank 3002 can be attached to the first ink inlet 3018 in the direction indicated by an arrow b in Fig. 40.

Also, if the scanning direction of the carrier 3102 is assumed to be in the direction indicated by an arrow a in Fig. 40 when the head cartridge 3101 is mounted on the carrier 3102, the ink tank 3002 which is attached to the second ink supply inlet 3019 is not protruded above the recording apparatus. Thus, the total height can be lowered. When the ink tank 3002 is attached to the first ink inlet 3018, it is possible to narrow the width of the carrier 3102. Thus, the total width of the recording apparatus can be narrowed. Further, in a case where another ink supply inlet is provided to allow the ink tank 3002 to be attached in the direction indicated by an arrow c in Fig. 40, the total width of the recording apparatus can also be narrowed.

As described above, with the structure which allows the coupling direction of the recording head 3001 and ink tank 3002 to be provided in two or more directions, it is possible to obtain an effect that with only one recording head 3001, the mode of head cartridge 3101 can be varied to meet many kinds of recording apparatuses; thus enabling its versatility to be enhanced to provide a desirable efficiency.

Fig. 41 is a perspective view illustrating the structure of a further embodiment according to the present invention. To be specific, the present embodiment is to constitute a color recording head by the utilization of the recording head 3001 in the embodiment described in conjunction with Fig. 40.

In Fig. 41, the recording head 3001 and ink tank 3002 comprise the recording heads 1BK, 1Y, 1M, and 1C which eject color ink materials of black (Bk), yellow (Y), magenta (M), and cyanogen (C), respectively, and ink tanks 2BK, 2Y, 2M, and 2C. The directions indicated by arrows in Fig. 41 represent those in which ink materials are ejected.

For the configuration of the above-mentioned recording head 3001, the same type of head used in the embodiment described in Fig. 40 can be used. For the structure of the liquid passage between the head and ink tank 3002, the first ink supply inlet 3018 is also usable. Here, in a case of heads for color recording, it is required to maintain the precision with which to position the recording heads themselves accurately.

Therefore, a positioning protrusion 3020 is provided on the side of the recording head 1 opposite to a second ink supply inlet. This is coupled to the second ink supply inlet of the adjacent recording head. In this way, the positioning may be arranged.

Also, ink supply inlets can be arranged in the direction indicated by an arrow c in Fig. 41 and the ink tank 3002 may be connected in such a direction as matter of course.

As described above, the installation direction of the recording head 3001 and ink tank 3002 are made arrangeable in two directions or more and then a plurality of these recording heads 3001 and ink tanks 3002 are made usable. Hence, the following effects can be obtained:

It is possible to simply obtain a color recording cartridge by adding head cartridges for plural colors to the head cartridge 3101 which is usually used for a single color.

Also, by arranging the size of an ink tank 3002 for the use of a single color and that of the recording head 3001 which is added for recording in multicolor substantially the same, it is possible to perform a single color recording and a multicolor recording with a carrier which can be shared for the purpose. Hence, it becomes possible to provide a compact color recording apparatus at a low cost. Further, by utilizing the ink supply inlet for positioning, it is possible to accurately execute the positioning between heads for a high quality color recording.

Fig. 42 illustrates another embodiment. In a recording head 4002a, a detaching and holding lever 4002f is provided for an ink cartridge 4002. This lever 4002f can be held down with its mounting shaft 4002g as pivot. When an ink jet cartridge 4002 is installed in the carrier, the lever is raised in the direction opposite to the ink ejection direction as indicated by solid lines in Fig. 42 so as to install it in the direction indicated by an arrow A with the aforesaid mounting shaft 4002g being fitted along the carrier guide grooves 4001c. Then, as shown in Fig. 43, when the mounting shaft 4002g reaches the bottom of the guide grooves 4001c and becomes no longer shiftable, the lever 4002f is rotated in the direction B by 90 degrees to hold the carrier 4001. In practice, it is preferable to provide a click function or the like to improve the sense of operation. At this juncture, the elongated cylindrical portions 4002h provided for the lever 4002f are regulated by the walls 4001e of the positioning grooves 4001d and are shifted by ε to the left in Fig. 43. By this shift, the contact between the recording head 4002a and carrier 4001 is made to electrically connect them.

Now, still another embodiment will be described. As shown in Fig. 44, the present embodiment is such that the ink jet cartridge detaching and holding lever 4002f provided for the recording head 4002a in the foregoing embodiment described in conjunction with Fig. 42 is arranged on the ink tank 4002c. Any structures other than this are the same as the embodiment in Fig. 42.

Subsequently, still another embodiment will be described. As shown in Fig. 45, the present embodiment is applicable to the structure wherein the recording head 4002a and ink tank 4002b are separable. In the present embodiment, the elongated cylindrical portions 4002k of the ink tank lever 4002j are made larger. Accordingly, the shiftable amount ε is also made larger by that much. As shown in Fig. 46, this is needed to insert the connecting rod 4002d of the recording head 4002a into the connecting hole 4002e of the ink tank 4002b.

Now, still another embodiment will be described. As shown in Fig. 47, the present embodiment is a variation of the embodiment described in conjunction with Fig. 45. Its structure is arranged to hold the ink tank 4002b by the recording head 4002a. The guide grooves for the ink tank 4002b are provided on the recording head 4002a (4021) while the guide grooves for the recording head 4002a are provided on the carrier (4001f). In the present embodiment, the ink tank 4002b can be replaced independently by the ink tank lever 4002j, but the recording head 4002a cannot be replaced independently. It must be replaced in the mode of the ink jet cartridge while holding the ink tank 4002b.

With a structure such as this, the replacement can be made with only one operation whereas in the prior art the operation should be carried out twice when the recording head 4002a is replaced, that is, at first, the ink tank 4002b must be removed before the removal of the recording head 4002a.

Now, Figs. 48 and 49 illustrate another embodiment. Fig. 48 is a schematically perspective view showing a state before an ink tank is attached to a recordng head. Fig. 49 is a schematically perspective view showing a state after the ink tank is attached to the recording head.

In Figs. 48 and 49, a reference numeral 5006 designates an ink tank containing ink to supply ink to a recording head 5004 from the nozzle 5005 of the recording head 5004 through a hole 5007 provided for the ink tank 5006. Also, the recording head 5004 is coupled detachably to a hole 5003 of a carriage 5001 by a means which is not shown. Here, the scanning directions of the carriage 5001 are such as indicated by an arrow S in Fig. 48. The direction in which ink is ejected from the recording head 5004 to a recording medium is such as indicated by an arrow T in Fig. 48.

An operator of a recording apparatus removes an empty ink tank 5006 when it is known that ink in the ink tank 5006 is being exhausted and installs an ink tank 5006 containing ink on the recording head 5004.

In such a case, the ink tank 5006 is shifted from the position in Fig. 48 in the direction indicated by an arrow P in Fig. 48 to allow the nozzles 5005 of the re-

cording head 5004 to be coupled to the hole 5007 of the ink tank 5006. At this juncture, the ink tank 5006 engages with a stopper 5002 of the carriage 5001 before it is butted against the recording head 5004 (Fig. 49).

With the provision of the stopper 5002 on the carriage 5001 in this way, the ink tank 5006 is allowed to engage with the stopper 5002 of the carriage 5001 before butting the recording head 5004 even if an excessive force is given to the ink tank 5006 when the ink tank 5006 is installed. Therefore, there is no possibility that the recording head 5004 is damaged.

Figs. 50 and 51 illustrate another embodiment. Fig. 50 a schematically perspective view showing a state before an ink tank is installed on a recording head. Fig. 51 is a schematically perspective view showing a state after the ink tank is installed on the recording head.

In Figs. 50 and 51, a reference numeral 5026 designates an ink tank containing ink to supply it from the ink supply nozzle 5005 of a recording head 5004 to the recording head 5004 through a hole 5028 provided for the ink tank 5026. Also, the recording head 5004 is detachably coupled to the hole 5021 of a carriage 5020 by a means which is not shown. Here, the scanning directions of the carriage 5020 are such as indicated by an arrow S while the ink ejection direction from the recording head 5004 to a recording medium is such as indicated by an arrow T. A reference numeral 5027 designates ink tank installation grooves provided on the ink tank 5026, which engage with the bosses 5025 arranged on a carriage lever 5024 installed to the upper holes 5023 of arms 5022 provided on both sides of the carriage 5020.

An operator raises the carriage lever 5024 to install the ink tank 5026 so that the grooves 5027 of the ink tank 5026 engage with the bosses 5025 when installing it on the recording head 5004 (Fig. 50). Then, the carriage lever 5024 is held down in the direction indicated by an arrow A. Thus, the ink tank 5026 is caused to be shifted in the direction (indicated by an arrow B) approaching the recording head 5004. The ink supply nozzle 5005 of the recording head 5004 and the hole 5028 of the ink tank 5026 are coupled (Fig. 51). In this case, even if an operator gives an excessive force to the carriage lever 5024, a stopper 5029 arranged on the carriage lever 5024 is caused to butt the carriage 5020 and the ink tank 5026 can no longer approach the recording head 5004. Here, Fig. 52 illustrates the recording head 5004 in the embodiment described in Fig. 50 and the positional relationship between the grooves 5027 of the ink tank 5026 and the bosses 5025 of the carriage lever 5024. Now, even if an operator erroneously presses the ink tank 5026 in the direction approaching the recording head 5004, the ink tank 5026 will not push the recording head 5004 because as shown in Fig. 52 a space y between the recording head 5004 and ink tank 5026 is greater than a space x between the bosses 5025 and grooves 5027 to maintain a relationship ($y > x$).

With the strucutre as described above, even when an excessive force is added to the ink tank 5026, there is no possibility that the recording head 5004 is damaged.

Also, in the present embodiment, the bosses 5025 are arranged on the carriage lever 5024, but it is not necessarily to configure them to be boss type only if some protrusions can be provided instead.

Figs. 53 to 56 illustrate still another embodiment. Fig. 53 shows schematically an ink tank itself. Fig. 54 is a side view of the ink tank viewed in the direction indicated by an arrow C in Fig. 53. Fig. 55 is a schematically perspective view illustrating the state where the recording head is installed on a carriage before the ink tank is mounted on the carriage. Fig. 56 is a schematically perspective view illustrating the state where the ink tank is attached to the recording head installed on the carriage.

In Figs. 53, 54, and 55, a reference numeral 5046 designates an ink tank containing ink in it. Ink is supplied to the recording head 5004 from the ink supply nozzle 5005 of the recording head 5004 through the hole 5048 of the ink tank 5046. Also, the recording head 5004 is detachable coupled to the hole 5041 of the carriage 5040 by a means which is not shown. A reference numeral 5042 designates a guide provided to guide the carriage 5040 for the ink tank installation, and also 5047, a stopper rib provided for the ink tank 5046.

An operator inserts the ink tank 5046 into the guide 5042 of the carriage 5040 from the hole 5048 in the direction indicated by an arrow D in Fig. 55 so as to allow the direction (E) of the ink tank 5046 where no rib 5047 is provided to be matched with the F portion of the carriage 5040 when the ink tank 5046 is attached to the recording head 5004. The ink tank is inserted until the rib 5047 of the ink tank 5046 butts the edge 5043 of the guide 5042. Thus, the ink supply nozzle 5005 of the recording head 5004 and the hole 5048 of the ink tank 5046 are coupled to complete the installation of the ink tank 5046 (Fig. 56).

By providing the stopper rib 5047 for the ink tank 5046 as described above, there is no possibility that the recording head 5004 is damaged even when the recording head 5004 is pushed due to an excessive force given to the ink tank 5046.

Figs. 57 to 59 illustrate still a further embodiment. Fig. 57 is a schematically perspective view showing an ink tank itself. Fig. 58 is a schematically perspective view showing the state where a recording head is mounted on a carriage before the ink tank is installed on the carriage. Fig. 59 is a schematic perspective view showing the state where the ink tank is attached to the recording head installed on the carriage.

In Figs. 57 and 58, a reference numeral 5056 des-

ignates an ink tank containing ink in it. Ink is supplied to the recording head 5004 form the ink supply nozzle 5005 of the recording head 5004 through the hole 5058 of the ink tank 5056. Also, the recording head 5004 is detachably coupled to the hole 5051 of the carriage 5050 by means which is not shown. A reference numeral 5052 designates a guide provided for the carriage for the installation of the ink tank, and also, 5057, a stopper provided for the ink tank 5056, which engages with the groove 5053 of the guide 5052.

An operator inserts the ink tank 5026 into the guide 5052 of the carriage 5050 from the hole 5058 in the direction indicated by an arrow D in Fig. 58 so as to allow the protrusion 5057 of the ink tank 5056 and the groove 5053 of the carriage 5050 to be matched when the ink tank 5056 is attached to the recording head 5004. The ink tank is inserted until the protrusion 5057 butts the deepest portion of the groove 5053. Thus, the ink supply nozzle 5005 of the recording head 5004 and the hole 5058 of the ink tank 5056 are coupled to complete the installation of the ink tank 5056 (Fig. 59).

By providing the stopper protrusion 5057 of the ink tank 5056 as well as the groove 5053 on the guide 5052 of the carriage 5050 as described above, there is no possibility that the recording head 5004 is damaged even if the recording head 5004 is pushed by an excessive force added to the ink tank 5056.

Figs. 60A and 60B illustrate another embodiment. In an ink jet head 6101, an ink supply barrel 6104 serves as ink supply means. This shows a cylindrical outer appearance, which can be fitted into an ink supply outlet 6103, a recess provided for the ink tank 6102, with a desirable tightness. However, the interrelated positional relationship in coupling the ink jet head 6101 and ink tank 6102 is not determined only by ink supply means 6104 and the ink supply outlet 6103. The positioning is perfectly made three dimensionally further by fitting positioning pins 6105 and 6106 provided for the ink jet head 6101 into the positioning holes 6107 and 6108 provided for the ink tank 6102 as well as by allowing the members 6109 and 6110 which block detachment provided for the ink jet head 6101 to engage with the recesses 6111 and 6112 provided for the ink tank 6102. As shown in Figs. 60A and 60B, it is clear that the positioning means for coupling the ink jet head and ink tank is not dependent of ink supply means.

In the ink jet head 6101, the positions where the positioning pins 6105 and 6106 are arranged are not particularly conditioned. However, it is preferable to set them as far away as possible from the ink supply means in order to hinder its effects and to enhance the positioning accuracy. It is good enough to select convenient positions on the surface opposite to where ink jet head 6101 and ink tank 6102 are coupled. The selection of the position where the detachment blocking members are arranged requires a consideration for an easier releasing of the coupling in addition to the same views as described above. The positioning pins and detachment blocking members shown in Figs. 60A and 60B are merely one embodiment, respectively, and are not intended to be confined thereto.

The configurations of the ink supply barrel 6104 and ink supply outlet 6103 are not necessarily the constituents of the present invention, and can be selected arbitrarily. It is preferable, however, to form a cylindrical protrusion and an opposing recess from the viewpoint of preventing ink leakage.

Fig. 60B is a cross-sectional view taken along line X - X (shown in the ink tank 6102) after the ink cartridge 6101 and ink tank 6102 are coupled and illustrates the coupling states of positioning means 6106 and 6108 arrange on both members, respectively, and of the detachment blocking members 6109 and 6111. In this respect, a reference numeral 6115 designates an ink chamber.

Fig. 61 illustrates still another embodiment.

As far as an appropriate ink supply passage can be formed in a carriage 6301, it may be possible to use the carriage 6301 for positioning the ink jet head 6302 and ink tank 6303 by arranging a coupling between the ink jet head 6302 and carriage 6301 and a coupling between the ink tank 6303 and carriage 6301 in place of using the head cartridge of a type where an ink jet head and ink tank are coupled as in the embodiment described in Figs. 60A and 60B.

In this case, too, the ink supply barrels 6308 and 6309 which are interrelatedly conductive to each other are not used for positioning. For the carriage 6301, members 6304, 6405, 6306, and 6307 are provided dedicatedly for positioning only. Meanwhile, a structure is arranged to provide opposing recesses on the ink jet head 6302 and ink tank 6303. Hence, it becomes possible to position the ink jet head and ink tank accurately, although the ink supply barrels are formed cylindrical with a desirable tightness.

The ink jet head 6302 and ink tank 6303 are formed by resilient materials, respectively, and the detachment blocking members 6310, 6311, 6312, and 6313 are detachably coupled to the recesses 6314, 6315, 6316, and 6317 of the carriage 6301.

Figs. 62 to 65 illustrate still another embodiment. Fig. 62 is a schematically perspective view showing an ink tank itself. Fig. 63 is a schematically perspective view showing the state where a recording head is installed on a carriage before the ink tank is mounted on the carriage. Fig. 64 is a schematically perspective view showing the recording head, ink tank, and carriage before the ink tank is attached to the recording head. Fig. 65 is a schematically perspective view showing the state where the ink tank is attached to the recording head installed on the carriage.

In Figs. 62 and 63, a reference numeral 7026 des-

ignates an ink tank containing ink in it. Ink is supplied to the recording head 7004 from the ink supply nozzle 7005 of the recording head 7004 through the hole 7028 of the ink tank 7026. Also, the recording head 7004 is detachably coupled to the hole 7021 of the carriage 7020 by a means which is not shown. Here, the scanning direction of the carriage 7020 is such as indicated by an arrow S in Fig. 62 while the ink ejection direction of the recording head 7004 to a recording medium is such as indicated by an arrow T in Fig. 62. A reference numeral 7027 designates grooves provided for the ink tank 7026 to prevent any erroneous tank installation, which engage with the bosses 7025 arranged on the carriage lever 7024 rotatively mounted in the upper holes 7023 of the arms 7022 which are provided on both sides of the carriage 7020.

An operator installs the ink tank 7026 so that the grooves 7027 of the ink tank 7026 engage with the bosses 7025 while the carriage lever 7024 is held up when the ink tank 7026 is attached to the recording head 7004 (Fig. 64).

In this case, if the ink tank 7026 happens to be upside down or inside out, that is, directions other than the normal direction, when it is installed on the carriage 7020, the bosses and grooves 7027 are not matched and even the installation on the carriage 7020 is impossible.

Subsequently, the carriage lever 7024 is held down in the direction indicated by an arrow A. In this way, the ink tank 7026 is allowed to shift in the direction approaching the recording head 7004 (indicated by an arrow B). The ink supply nozzle 7005 of the recording head 7004 is coupled to the hole 7028 of the ink tank 7026 to complete the installation of the ink tank 7026. At this juncture, a stopper 7029 provided for the carriage lever 7024 is allowed to butt the carriage 7024 (Fig. 65).

As described above, the grooves 7027 are provided as shown in Fig. 62 in the position apart from the center of the ink tank 7026 while the bosses 7025 which engage with the grooves 7027 are provided on the carriage 7020. Hence, it becomes possible to prevent any erroneous installation of the ink tank 7026 on the carriage 7020.

Also, in the present embodiment, the bosses 7025 are provided for the carriage lever 7024, but the bosses 7025 are not necessarily limited to that shape, if only these are in a protruded shape.

Figs. 66 to 69 illustrate still another embodiment. Fig. 66 is a schematically perspective view showing an ink tank itself. Fig. 67 is a schematically perspective view showing the state where a recording head is installed on a carriage before the ink tank is mounted on the carriage. Fig. 68 is a schematically perspective view showing the recording head, ink tank, and carriage before the ink tank is attached to the recording head. Fig. 69 is a schematically perspective view showing the state where the ink tank is attached to the recording head installed on the carriage.

In Figs. 66 and 67, a reference numeral 7036 designates an ink tank containing ink in it. Ink is supplied to the recording head 7004 from the ink supply nozzle 7005 of the recording head 7004 through the hole 7038 of the ink tank 7036. Also, the recording head 7004 is detachably coupled to the hole 7021 of the carriage 7020 by a means which is not shown. A reference numeral 7037 designates grooves provided for the ink tank 7036 which engage with the bosses 7025 arranged on the carriage lever 7024 rotatively mounted in the upper holes 7023 of the arms 7022 which are provided on both sides of the carriage 7020.

An operator installs the ink tank 7036 so that the wall 7039 of the ink tank 7036 can be placed on the recording head 7004 side, and also the grooves 7037 engage with bosses 7025 while the carriage lever 7024 is held up when the ink tank 7036 is attached to the recording head 7004 (Fig, 68). In this case, if the ink tank 7036 happens to be upside down or inside out, that is, directions other than the normal direction, when it is installed on the carriage 7020, the wall 7039 is blocked by the recording head 7004 or the bosses 7025 are not matched with the position of the grooves 7037, and even the installation on the carriage 7020 is impossible.

Subsequently, the carriage lever 7024 is held down in the direction indicated by arrow A. Thus, the ink tank 7036 is shifted in the direction approaching the recording head 7004 (direction indicated by an arrow B), and the ink supply nozzle 7005 of the recording head 7004 is coupled to the hole 7038 of the ink tank 7036 to complete the installation of the ink tank 7036 (Fig. 69).

As described above, the wall 7039 is provided at the end portion of the ink tank 7036 and further, the grooves 7037 are provide away from the center of the ink tank 7036 while the bosses 7025 which engage with the grooves 7037 are provided on the carriage 7020. Hence, it becomes possible to prevent any erroneous installation of the ink tank 7036 on the carriage 7020.

Also, in the present embodiment, the bosses 7025 are provided for the carriage lower 7024, but the bosses 7025 are not necessarily limited to that shape, if only these are in a protruded shape.

Figs. 70 to 73 illustrate still another embodiment. Fig. 70 is a schematically perspective view showing an ink tank itself. Fig. 71 is a side view schematically showing the ink tank viewed in the direction indicated by an arrow C in Fig. 70. Fig. 72 is a schematically perspective view showing the state where a recording head is installed on a carrier before the ink tank is mounted on the carriage. Fig. 73 is a schematically perspective view showing the state where the ink tank is attached to the recording head installed on the

carriage.

In Figs. 70, 71, and 72, a reference numeral 7046 designates an ink tank containing ink in it. Ink is supplied to the recording head 7004 from the ink supply nozzle 7005 of the recording head 7004 through the hole 7048 of the ink tank 7046. Also, the recording head 7004 is detachably coupled to the hole 7041 of the carriage 7040 by a means which is not shown. A reference numeral 7042 designates an ink tank installation guide provided for the carriage 7042, and also 7047, a rib to prevent the erroneous installation of the ink tank 7047.

An operator inserts the ink tank 7046 into the guide 7042 of the carriage 7040 in the direction indicated by an arrow D in Fig. 72 from the hole 7048 so as to match the direction (E) in which no rib 7047 is present for the ink tank 7046 with the portion F of the carriage 7040 when the ink tank 7046 is attached to the recording head 7004. The ink tank is inserted until the rib 7047 of the ink tank 7046 is allowed to butt the edge 7043 of the guide 7042 of the carriage 7040. Thus, the ink supply nozzle 7005 of the recording head 7004 is coupled to the hole 7048 of the ink tank 7046 to complete the ink tank installation (Fig. 73).

In this case, if the ink tank 7046 happens to be upside down or inside out, that is, in the directions other than the one regulated, when it is mounted on the carriage 7040, the rib 7047 stands in the way so that the carriage 7040 cannot be inserted into the guide 7042; thus disabling the installation.

As described above, the rib 7047 is arranged at the end of the ink tank 7046 for the provision of the guide 7042 on the carriage 7040 thereby to prevent the ink tank 7046 from being incorrectly mounted on the carriage 7040.

Figs. 74 to 76 illustrate still another embodiment. Fig. 74 is a schematically perspective view showing an ink tank itself. Fig. 75 is a schematically perspective view showing the state where a recording head is installed on a carriage before the ink tank is mounted on the carriage. Fig. 76 is a schematically perspective view showing the state where the ink tank is attached to the recording head installed on the carriage.

In Figs. 74 and 75, a reference numeral 7056 designates an ink tank containing ink in it. Ink is supplied to the recording head 7004 from the ink supply nozzle 7005 of the recording head 7004 through the hole 7058 of the ink tank 7056. Also, the recording head 7004 is detachably coupled to the hole 7051 of the carriage 7050 by means which is not shown. A reference numeral 7052 designates an ink tank installation guide provided for the carriage 7050; 7057, a protrusion to prevent the ink tank from being erroneously mounted; and 7053, a groove provided for the carriage to prevent the ink tank from being erroneously mounted.

When an operator mounts the ink tank 7056 on the recording head 7004, the ink tank 7056 is inserted into the guide 7052 of the carriage from the hole 7058 in the direction indicated by an arrow D in Fig. 75 so the protrusion 7057 of the ink tank 7056 and the groove 7053 of the carriage 7050 are matched. The ink tank is inserted until the protrusion 7057 butts the end of the groove 7053. Thus, the ink supply nozzle 7005 of the recording head 7004 and the hole 7058 of the ink tank 7056 are coupled to compete the installation of the ink tank 7056 (Fig. 76).

In this case, if the ink tank 7056 happens to be upside down or inside out or any other directions than normally regulated, the ink tank cannot be inserted into the guide 7052 of the carriage 7050 because it is blocked by the protrusion 7057; disabling its installation.

As described above, it is thus possible to prevent the ink tank 7056 from being installed incorrectly into the carriage 7050 by providing the protrusion for the ink tank 7056 as well as the groove 7053 for the guide 7052 of the carriage 7050.

Fig. 77 illustrates, as another embodiment, the state where a head cartridge 8002 is separated from a recording head 8002a and ink tank 8002b.

In the present embodiment, the recording head 8002a and ink tank 8002b are coupled in such a manner that an ink supply tube 8002a4 formed in the recording head 8002a to supply ink to the recording head 8002a from the ink tank 8002b is coupled to a seal ring 8002b4 provided for the ink tank 8002b to prevent ink leakage by being fitted into the foregoing ink supply tube 8002a4, and then locking nails 8002b3 formed on the ink tank 8002b are coupled to the receptacles 8002a3 provided for the recording head 8002a to receive the foregoing locking nails 8002b3. Reference numerals 8002a1 and 8002b1 designate the matching marks provided for the ink tank 8002b to indicate a correct position of the inserting amount when being coupled; 8002a2 and 8002b2, marks provided for the recording head 8002a and ink tank 8002b, respectively, to indicate the direction in which these are coupled and are arranged in stripes of different colors from the recording head 8002a and ink tank 8002b, lines engraved, or the like to facilitate discriminating the coupling direction of the recording head 8002a and ink tank 8002b when separated; 8002a5, a contact to make electrical connection between the carrier 8001 and recording head 8002a when the head cartridge 8002 is mounted on the carrier 8001; and 8002b5, a receptacle for a lock lever (to be described later) to fix the head cartridge 8002 to the carrier when the head carriage 8002 is mounted on the carrier 8001.

Fig. 78 illustrates the state where the recording head 8002a and ink tank 8002b are on the way to be coupled.

When the ink tank 8002b is being inserted into the recording head 8002a, a load is more increased

in pressing it where the locking nails 8002b3 butt the locking nail receptacles 8002a3. However, in this state, the matching marks 8002a1 and 8002b1 are still displaced. Thus, an operator can recognize that the coupling is still incomplete.

When the ink tank 8002b is further pressed, the arms of the locking nails 8002b3 are bent to climb over the receptacles 8002a3 to allow them to be joined correctly. Then, the matching marks 8002a1 and 8002b1 are matched. Fig. 79 illustrates this state.

Fig. 80 illustrates the state where the head cartridge 8002 is mounted on the carrier. Here, the recording head 8002a and ink tank 8002b are not particularly coupled securely. There is still a space between them in such a coupling state of the head cartridge 8002 shown in Fig. 80. In the present embodiment, a correct installation is possible even in such a state as this.

In Fig. 80, there are provided for the carrier 8001 an electrical contact 8001a to make electrical connection with the recording head 8002a; a resilient member 8001b made of rubber or the like to give pressure needed for the electrical contact; an operation lever 8001c to mount or demount the head cartridge 8002; a cartridge locking lever 8001d to fix the head cartridge to the carrier 8001; a lever spring 8001e to bias the operation lever 8001c; a push lever 8001f to support the head cartridge 8002 from the beneath; and an interlocking lever 8001g to move the foregoing push lever 8001f. The four components, the operation lever 8001c, cartridge locking lever 8001d, push lever 8001f, and interlocking lever 8001g, are axially supported at a same point. The three components, the operation lever 8001c, cartridge locking lever 8001d, and interlocking lever 8001g, are interlockingly fixed and operated in synchronism while the movement of the operation lever 8001c is transferred to the push lever 8001f through the interlocking lever 8001g.

When there is no cartridge 8002 on the carrier 8001, the above-mentioned levers are biased by the lever spring 8001e in clockwise in Fig. 80. The state shown in Fig. 80 is such that the head cartridge is mounted under this condition. From this state, the operation lever 8001c is rotated in the direction indicated by an arrow c. Then, the leading end of the push lever 8001f is lowered to cause the head cartridge 8002 to be lowered likewise. As the operation lever 8001c is further rotated, the interlocking lever 8001g is parted from the push lever 8001f and is no longer rotated; thus the state becoming as represented in Fig. 81. When the operation lever 8001c is further rotated, the cartridge locking lever 8001d begins to push the ink tank 8002b. Here, even if there is a space due to incomplete coupling of the recording head 8002a and ink tank 8002b, the ink tank is pressed by the cartridge locking lever 8001d in the mounting direction. Hence, ultimately, the recording head 8002a and ink tank 8002b are completely coupled as far as the head cartridge 8002 is mounted on the carrier 8001.

Fig. 81 illustrates the state where the head cartridge 8002 is fixed to the carrier. From this state, when the operation lever 8001c is rotated in counterclockwise, the leading end of the cartridge locking lever 8001d reaches the lower side of the rotational center of the lever (Fig. 82). Thus, by the force exerted by the resilient member 8001b, the cartridge locking lever 8001d is further pressed in counterclockwise against hte force exerted by the lever spring 8001e. Thus, the cartridge locking lever 8001d becomes locked.

Now, as still another embodiment, the description will be made of a case where the coupling indication marks are provided for a type which stores an ink tank in a recording head housing. Fig. 83 is a schematically perspective view illustrating a recording head and ink tank according to the present embodiment. Fig. 84 is a plan view. In Fig. 83, a reference numeral 8200 designates a recording head and 8220, an ink tank. For the foregoing recording head 8200 there are provided a nozzle unit 8201 to eject ink droplets; a supply tube 8202 to receive the ink supply from an ink tank 8220; a window 8203 to examine matching marks; marching marks 8204; finger stays 8205 for the removal of ink tank 8220; and locking nails 8206 to fix the ink tank 8220. For the foregoing ink tank 8220 there are provided matching lines 8221; finger stays 8222 for installation use; an ink supply outlet to supply ink to the foregoing recording head 8200; and receptacles 8224 to receive the foregoing locking nails 8206.

The coupling of the ink tank 8220 is conducted by inserting the ink tank in the direction indicated by an arrow.

As shown in the left-hand side in Fig. 84, when the ink tank 8220 is inserted into the correct position, the matching mark 8204 of the recording head 8200 and the matching line 8221 of the ink tank 8220 are matched. Hence, it is easy to discriminate whether the installation is correctly conducted or not. If the installation is incorrect, the matching mark 8204 and matching line 8221 are displaced as shown in the right-hand side in Fig. 83. Since the examination window 8203 is diagonally provided with respect to the installation direction, even a slight displacement in the installation direction is emphatically indicated so as to make discrimination easier.

As still another embodiment, Fig. 85 illustrates a case where a click is provided for the coupling of a head cartridge and carrier in a mode that an ink tank is stored in the recording head housing. Fig. 85 is a schematically perspective view showing a recording head and ink tank according to the present embodiment. For each element which has the same function as above, the same reference mark is provided in the corresponding location, and the description thereof

will be omitted.

In Fig. 85, the ink tank 8002b is installed in the direction indicated by an arrow A with respect to the recording head 8002a, and these are coupled by clicking of the nails 8002a6 arranged in two locations on the recurrent head side and the receptacles 8002a6 on the ink tank side. The recording head 8002a is installed in the direction indicated by an arrow B which is the same as the direction indicated by the arrow A with respect to the carrier 8001 and is coupled thereto by clicking of a spring 8001h and a receiving portion 8002a7. The ink tank 8002b can be replaced alone even in a state where the recording head 8002a is coupled to the carrier 8001, but since the ink tank 8002b and recording head 8002a are mounted or demounted in the same direction, the strength of the click for coupling for the ink tank 8002b should be set weaker than that of the click for coupling the recording head 8002a. In this way, when only the ink tank 8002b is replaced, it is possible to prevent the recording head 8002a from being removed together with the ink tank by mistake.

Also, as shown in Fig. 86, the installation direction of the recording head 8002a and that of the ink tank 8002b are made different. As a result, it becomes possible to reliably conduct the installations of the ink tank and recording head separately.

In Fig. 86, although the way to couple the ink tank 8002b and recording head 8002a are the same as the case described in conjunction with Fig. 85, the directions in which the recording head 8002a and carrier 8001 are coupled are different. In order to couple the recording head 8002a to the carrier 8001, the recording head 8002a must be slight displaced at first before being mounted on the carrier 8001. If the amount of such a displacement is not enough, a pin 8002a9 is caused to butt a slop 8001n provided for the carrier to displace the recording head 8002a in the horizontal direction, at the same time preventing the intervention of the nails 8001m and receptacles 8002a8. When the recording head 8002a is mounted on the carrier as indicated by an arrow D, it is shifted in the horizontal direction to complete the installation by clicking of the nails 8001m on the carrier side and the receptacles 8002a8 on the recording head side.

As shown in Fig. 87, the recording head 9002a and ink tank 9002b are coupled by inserting a connecting rod 9002d into a connecting hole 9002e. The connection and separation operations are executed on the carrier 9001a by lever and the like provided for the carrier. Here, the description and representation of such operations by a drawing will be omitted.

Usually, the ink jet cartridge 9002 with the recording head 9002a and ink tank 9002b being coupled is mounted on a carrier to operate printing. A reference numeral 9043 designates an absorbent according to the present invention and is made of a high molecular polymer or the like. It is adhesively arranged on the carrier by a double coated adhesive tape or the like so that the absorbent is placed beneath the coupling portion of the connecting rod 9002d and connection hole 9002e, that is, it is provided in the vicinity of the coupling portion of the recording head and ink tank. Therefore, when the recording head 9002a and ink tank 9002b are separated, the absorbent 9043 receives ink dropping from the outer periphery of the connecting rod 9002d and the end of the connecting hole 9002e and holds such ink droplets to prevent them from flowing outside. Here, the vicinity of the coupling portion means in the present invention that the area including the coupling portion and its vicinity where ink leakage or ink scattering takes place when the recording head and ink tank are separated.

Now, still another embodiment will be described.

As shown in Fig. 88, a groove 9001b is provided beneath the coupling portion of the connecting rod 9002d and connection hole 9002e for the carrier 9001. The present embodiment is effective when the absorbent 9043 shown in the embodiment described in conjunction with Fig. 87 cannot be placed at a desired location. With the present embodiment, it is possible to allow the absorbent 9043 to be adhesively arranged at an arbitrary position. At first, ink dropping from the coupling portion is received by the groove 9001b, and by capillary phenomenon, it flows along the groove 9001b. Ultimately, it reaches the absorbent 9043 adhering to the trailing end of the groove and then held there.

Subsequently, still another embodiment will be described.

As shown in Fig. 89, the absorbent 9043 is arranged adhere to the recording head 9002a. Also, in Fig. 90, the absorbent 9043 is fitted around the outer periphery of the connecting rod 9002d and pressed onto the ink tank 9002c side by a compression spring 9044. Thus, when separated, it is removed from the connecting rod 9002d while absorbing ink existing on the outer periphery of the connecting rod 9002d. Further, a groove is provided for at least one of the recording head 9002a and ink tank 9002c; thus arranging a structure which can bring about the same effect as the embodiment described in conjunction with Fig. 88.

Subsequently, another embodiment will be described.

As shwon in Fig. 91, the present embodiment is such that the absorbent in the embodiment described in conjunction with Fig. 87 is arranged on the ink tank side.

Now, still another embodiment will be described.

As shown in Fig. 92, the present embodiment is such that a water repellent treatment is given to the connecting rod 9002d while a hydrophilic treatment is given to the connecting hole 9002e. In the case, ink does not adhere to the connecting rod 9002d to which the water repellent treatment is given. It always ad-

heres to the ink hole 9002e where the hydrophilic treatment is conducted. As a result, there will be no ink leakage from inside the ink tank 9002c to the outside.

Fig. 93 illustrates another embodiment and is a block diagram showing a circuit to detect the ink tank and ink amount using a detection terminal 9360 and detection pin 9380. This circuit is provided in the ink jet recording apparatus body described earlier.

In Fig. 93, whether the ink tank is present and also a sufficient amount of ink exists or not is determined by the discriminating circuit 9300 on the basis of the detection results of the current detection circuit 9200 in accordance with the contact/ non-contact between the detection terminal 9360 and detection pin 9380 as well as the existing amount of ink as described above. The signals carrying the detection results are transmitted to a control circuit 9400. The control circuit 9400 is installed in the ink tank 9900. If it is found that ink exists, the usual recording operation such as driving of the recording head will be conducted through the carriage driving (driving circuit for this is not shown) and recording head driving circuit 9500. On the other hand, if the discriminating circuit 9300 detects no ink. Then, the control circuit 9400 causes the recording operation to be disabled.

Also, the control circuit 9400 causes an indication device 9600 to indicate the results output from the discriminating circuit 9300.

In this respect, according to the present embodiment, the detection is conducted by two detection pins 9380 to detect the presence of ink, but it may be possible to detect the remaining amount of ink by detecting the material value of ink using the two detection pins 9380.

Also, in the present embodiment, the current detection circuit 9200 and discriminating circuit 9300 are provided on the recording apparatus side, but it may be possible to arrange them on the head cartridge side.

In another embodiment the details of which are shown in Fig. 94, the detection terminal 9360 to detect the presence of the ink tank 9900 is arranged on the carriage HC side. Hence, it becomes possible to detect the presence of ink tank and ink as well in accordance with the installation of the head cartridge on the carriage HC.

As described above, each of the embodiments is effective by itself, but it may be possible to combine a plurality of these embodiments in order to provide an ink jet recording apparatus having a higher reliability.

In this respect, particularly among ink jet recording methods, the present invention produces an excellent effects on a recording head and recording apparatus which creates change of state in ink with means provided to generate thermal energy to be utilized for ejecting ink (electrothermal transducers, laser beam, or the like, for example).

Regarding the typical structure and operational principle of such a mehtod, it is preferable to adopt those which can be implemented using the fundamental principle disclosed in the specifications of U.S. Patent Nos. 4,723,129 and 4,740,796. This method is applicable to so-called on-demand type recording system and a continuous type recording system. Particularly, however, it is suitable for the on-demand type because the principle is such that at least one driving signal, which provides a rapid temperature rise beyond a departure from nucleation boiling point in response to recording information, is applied to an electrothermal transducer disposed on a liquid (ink) retaining sheet or liquid passage whereby to cause the electrothermal transducer to generate thermal energy to produce film boiling on the thermoactive portion of the recording head; thus effectively leading to the resultant formation of a bubble in the recording liquid (ink) one to one for each of the driving signals. By the development and contraction of the bubble, the liquid (ink) is ejected through a discharging port to produce at least one droplet. The driving signal is preferably in the form of pulses because the development and contraction of the bubble can be effectuated instantaneously, and, therefore, the liquid (ink) is ejected with quick response.

The driving signal in the form of pulses is preferably such as disclosed in the specifications of U.S. Patent Nos. 4,463,359 and 4,345,262.

In addition, the temperature increasing rate of the heating surface is preferably such as disclosed in the specification of U.S. Patent No. 4,313,124 for an excellent recording in a better condition.

The structure of the recording head may be as shown in each of the above-mentioned the specifications wherein the structure is arranged to combine the discharging ports, liquid passages, and the electrothermal transducers as disclosed in the above-mentioned patents (linear type liquid passage or right angle liquid passage). Besides, the structure such as disclosed in the specifications of U.S. Patent Nos. 4,558,333 and 4,459,600 wherein the thermal activation portions are arranged in a curved area is also included in the present invention.

In addition, the present invention is applicable to the structure disclosed in japanese Laid-Open Application No. 59-123670 wherein a common slit is used as the discharging ports for plural electrothermal transducers, and to the structure disclosed in Japanese Patent Laid-Open Application No. 59-138461 wherein an opening for absorbing pressure wave of the thermal energy is formed corresponding to the discharging ports. In other words, according to the present invention, it becomes possible to operate the recording assuredly irrespective of the modes of the recording head.

Furthermore, as a full line type recording head

having a length corresponding to the maximum recording width, it may be possible to arrange a structure either by combining plural recording heads disclosed in the above-mentioned specifications or by a single recording head integrally constructed to cover such a length.

In addition, the present invention is applicable to a serial type recording head wherein the recording head is fixed on the main assembly, to a replaceable chip type recording head which is connected electrically with the main apparatus and can be supplied with ink when it is mounted in the in assemble, or to a cartridge type recording head having an intergral ink container.

Also, it is preferable to additionally provide recording head recovery means and preliminarily auxiliary means which are arranged as constituents of a recording apparatus according to the present invention. These elements will contribute to making the effectiveness of the present invention more stabilized. To name them specifically, such elements are capping means for the recording head, cleaning means, compression or suction means, preliminary heating means such as electrothermal transducers or heating elements other than such transducing type or the combination of those types of elements, and the preliminary ejection mode besides the regular ejection for recording.

As regards the kind and number of the recording heads mountable on the carriage, it may be a single color ink, or may be plural heads corresponding to a plurality of ink materials having different recording color or density. The present invention is effectively applicable to an apparatus having at least one of a monochromatic mode mainly with black, a multi-color mode with different color ink materials and/or a full-color mode using the mixture of the colors, which may be an integrally formed recording unit or a combination of plural recording heads.

Now, in the embodiments, according to the present invention set forth above, while the ink has been described as liquid, it may be an ink material which is solidified below the room temperature but liquefied at the room temperature. Since the ink is controlled within the temperature not lower than 30°C and not higher than 70°C to stabilize its viscosity for the provision of the stable ejection in general, the ink may be such that it can be liquefied when the applicable recording signals are given.

In addition, while preventing the temperature rise due to the thermal energy by the positive use of such energy as an energy consumed for changing states of the ink from solid to liquid, or using the ink which will be solidified when left intact for the purpose of preventing ink evaporation, it may be possible to apply to the present invention the use of an ink having a nature of being liquefied only by the application of thermal energy such as an ink capable of being ejected as ink liquid by enabling itself to be liquefied anyway when the thermal energy is given in accordance with recording signals, an ink which will have already begun solidifying itself by the time it reaches a recording medium.

For an ink such as this, it may be possible to retain the ink as a liquid or solid material in through holes or recesses formed in a porous sheet as disclosed in Japanese Patent Laid-Open Application No. 54-56847 or Japanese Patent Laid-Open Application No. 60-71260 in order to execute a mode whereby to enable the ink to face the electrothermal transducers in such a state.

For the present invention, the most effective method for each of the above-mentioned ink materials is the one which can implement the film boiling method described above.

Furthermore, as modes of the foregoing ink jet recording apparatus, a copying apparatus combined with reader and the like or a facsimile apparatus having transmission reception functions or the like may be employed in addition to those used as an image output terminal of an information processing apparatus such as a computer.

Claims

1. An ink jet recording apparatus comprising:
   an ink tank containing ink;
   a recording head for performing recording by selectively ejecting ink;
   a mounting portion for mounting said ink tank and said recording head;
   a liquid passage coupling portion provided on either or both of said ink tank and said recording for separating or connecting the ink passages in said ink tank and said recording head;
   a holding portion provided on either or both of said ink tank and said recording head for guiding said ink tank to said recording head to hold them separably;
   an electrically connecting portion provided on either or both of said recording head and said mounting portion for electrically connecting said recording head to or separating it from said mounting portion; and
   a mechanically connecting portion provided on either or both of said recording head and said mounting portion for mechanically connecting said recording head to or separating it from said mounting portion.

2. An ink jet recording apparatus according to Claim 1, wherein said ink tank can be attached or detached on said mounting portion.

3. An ink jet recording apparatus according to Claim

1, wherein said ink tank can be attached or detached on said mounting portion only when said recording head is mounted.

4. An ink jet recording apparatus according to Claim 1, wherein said recording head can be detached only when said ink tank is mounted.

5. An ink jet recording apparatus according to Claim 1, wherein said recording head can be attached or detached only when said ink tank is mounted.

6. An ink jet recording apparatus according to Claim 1, wherein said recording head is coupled by pressing said recording head to a carriage capable of shifting said recording head in a given direction.

7. An ink jet recording apparatus according to Claim 1, wherein said recording head and carriage can be electrically connected by pressing the recording head.

8. An ink jet recording apparatus according to Claim 1, wherein said ink tank and recording head are mounted on the carriage respectively by separate means.

9. An ink jet recording apparatus according to Claim 1, wherein said liquid passage coupling portion has at least two different coupling directions.

10. An ink jet recording apparatus according to Claim 1, wherein said liquid passage coupling portion has at least two different directions, and the coupling direction is varied by the rotation of the periphery of said liquid passage coupling portion.

11. An ink jet recording apparatus according to Claim 1, wherein said liquid passage coupling portion is provided in at least two locations or more on said recording head, and said ink tank is selectively separated from or coupled to any one of such a location or plural locations.

12. An ink jet recording apparatus according to Claim 1, wherein a member for attaching or detaching said recording head to or from the carrier and for holding the head on the carrier is arranged on said recording head.

13. An ink jet recording apparatus according to Claim 1, wherein a member for attaching or detaching said ink tank to or from the carrier and for holding the ink tank on the carrier is arranged on said ink tank.

14. An ink jet recording apparatus according to Claim 1, wherein an ink tank is held by a recording head, and a member for attaching or detaching said ink tank is arranged on said ink tank to attach or detach said recording head and said ink tank to or from the carrier, and further, a member for holding them on said carrier is arranged on said recording head.

15. An ink jet recording apparatus according to Claim 1, wherein means for regulating the direction in which said ink tank approaches the recordnig head is provided on said carriage.

16. An ink jet recording apparatus according to Claim 1, wherein means for regulating the direction in which said ink tank approaches the recording head is provided on said ink tank.

17. An ink jet recording apparatus according to Claim 1, wherein means for regulating the direction in which said ink tank approaches the recording head is provided on said carriage and ink tank.

18. An ink jet recording apparatus according to Claim 1, wherein a coupling and positioning portion is provided to indicate whether said recording head and said ink tank are completely coupled or not.

19. An ink jet recording apparatus according to Claim 1, wherein in the vicinity of said liquid passage coupling portion, any one of or a combination of an absorbent, groove, and hydrophilic or water repellent portion is provided on said mounting portion for preventing ink scattering.

20. An ink jet recording apparatus according to Claim 1, wherein in the vicinity of said liquid passage coupling portion, any one of or a combination of an absorbent, groove, and hydrophilic or water repellent portion is provided on said recording head for preventing ink scattering.

21. An ink jet recording apparatus according to Claim 1, wherein in the vicinity of said liquid passage coupling portion, any one of or a combination of a absorbent, groove, and hydrophilic or water repellent portion is provided on said ink tank for preventing ink scattering.

22. An ink jet recording apparatus according to Claim 1, wherein said apparatus comprises:

detecting means for detecting the installation of said ink tank in said ink jet recording apparatus; and

controlling means for controlling the recording operation of said ink jet recording apparatus in accordance with the detected results of said detecting means.

23. An ink jet recording apparatus according to Claim 22, wherein said detecting means also serves to detect the remaining amount of ink is said ink tank.

24. An ink jet recording apparatus according to Claim 23, wherein indicating means is provided for indicating the results detected by said detecting means.

25. An ink jet recording apparatus according to Claim 23, wherein said controlling means is structured to disable the recording operation when said ink tank is not installed in said ink jet recording apparatus.

26. An ink jet recording apparatus according to any one of Claims 1 to 25, wherein said recording head generates bubbles by utilizing thermal energy and eject ink on the basis of the development of said bubbles.

27. A method for installing an ink jet recording head for performing recording on a recording medium, wherein the electrical connection of said recording head is pressed against an electrically connecting portion for mounting a head cartridge to which a recording head and ink tank separable from each other are coupled to enable ink supply, and said recording head is installed on said carriage.

28. A method for installing an ink jet recording head according to Claim 27, wherein said ink jet recording head ejects ink to perform recording by utilizing film boiling generated by thermal energy generated by electrothermal transducers by energizing said electrothermal transducers in accordance with signals.

29. A cartridge for ink jet recording apparatus including a detachable recording head connectable directly to an ink cartridge.

FIG. 1

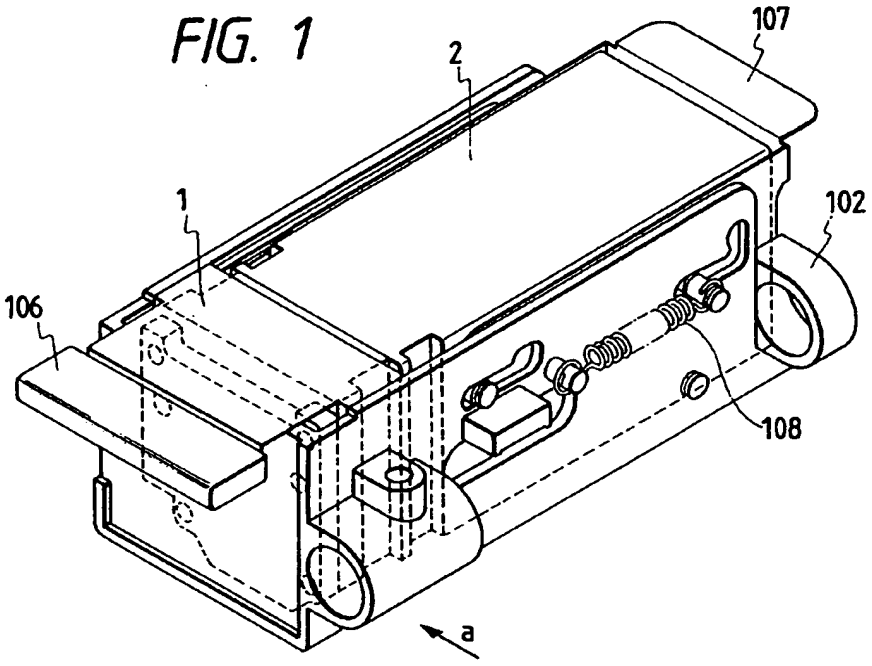


FIG. 2

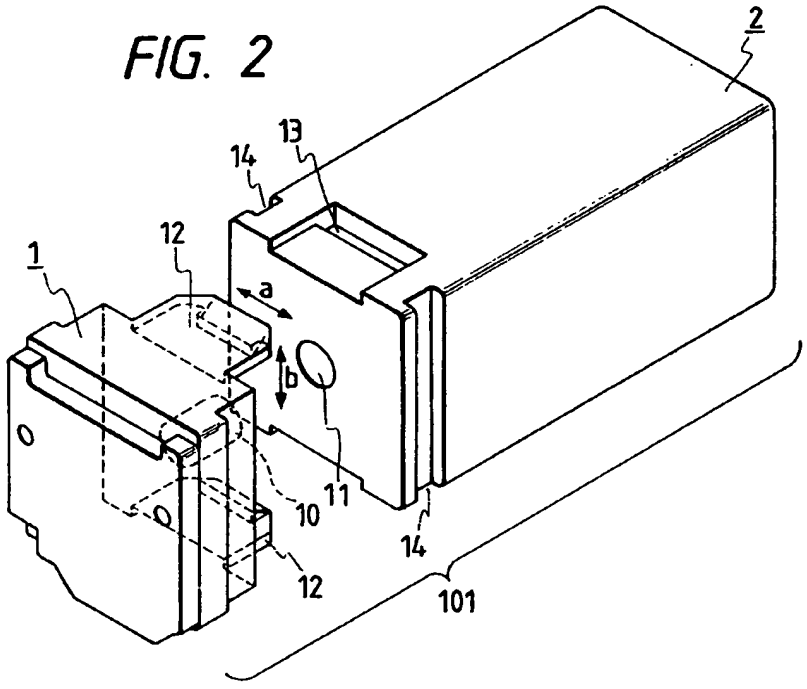


FIG. 3

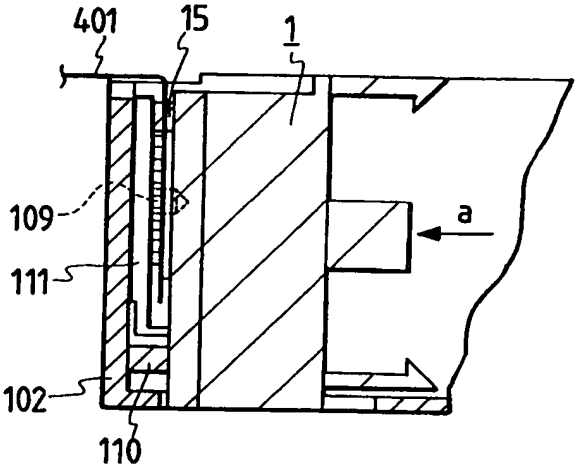


FIG. 4

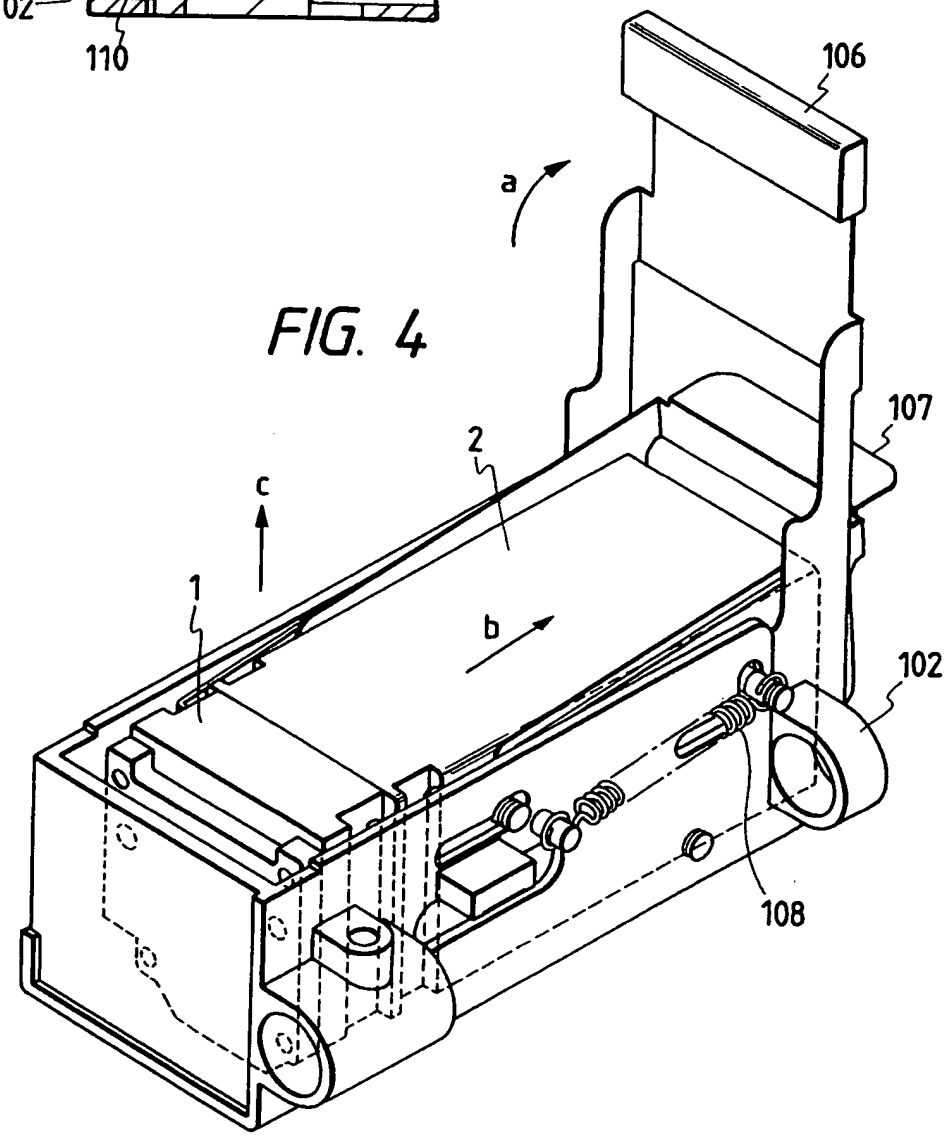


FIG. 5

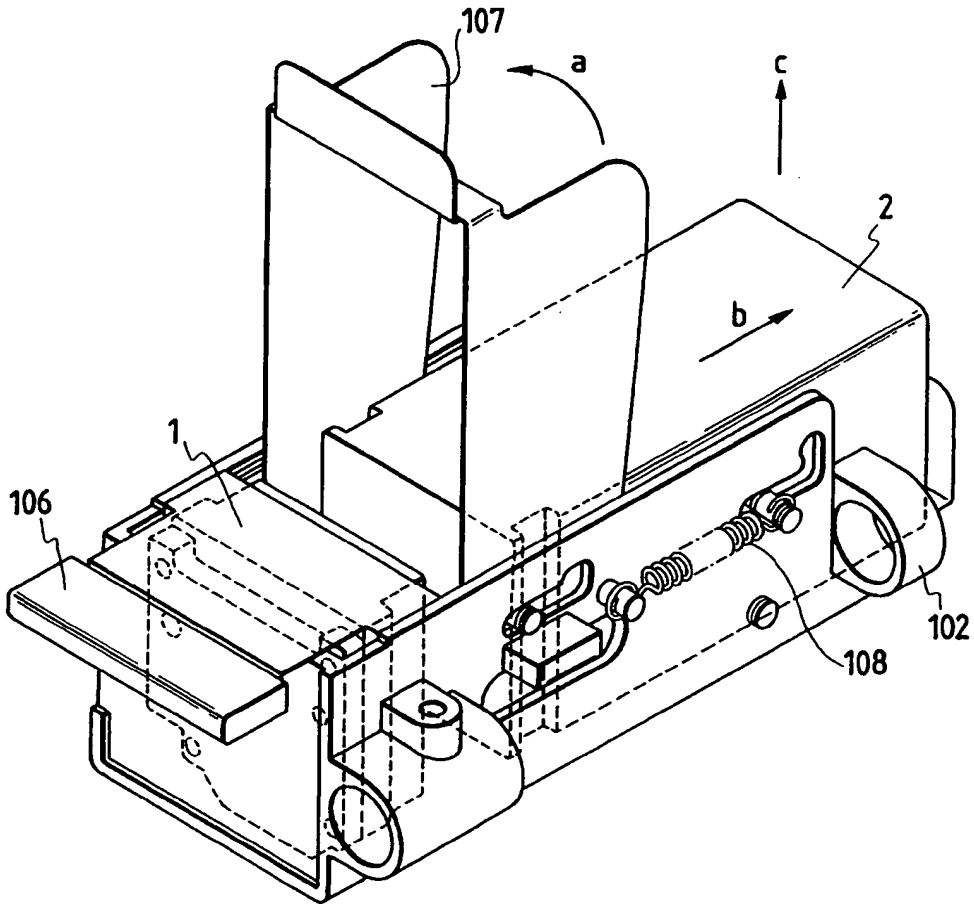


FIG. 6

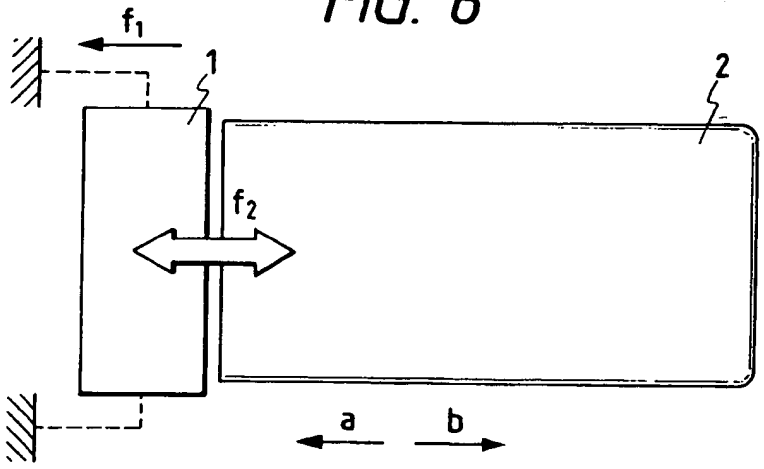
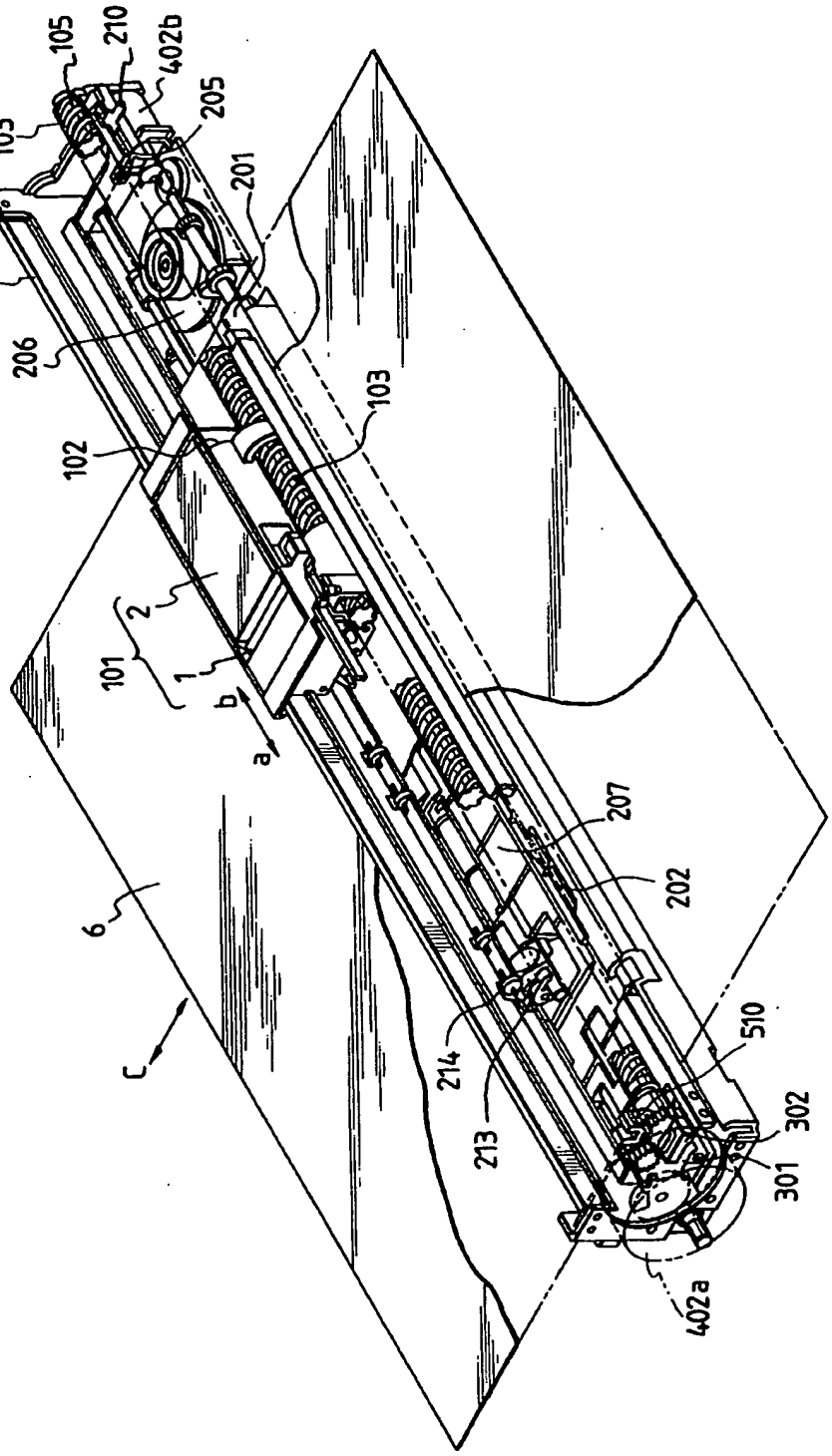


FIG. 7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402a

FIG. 8

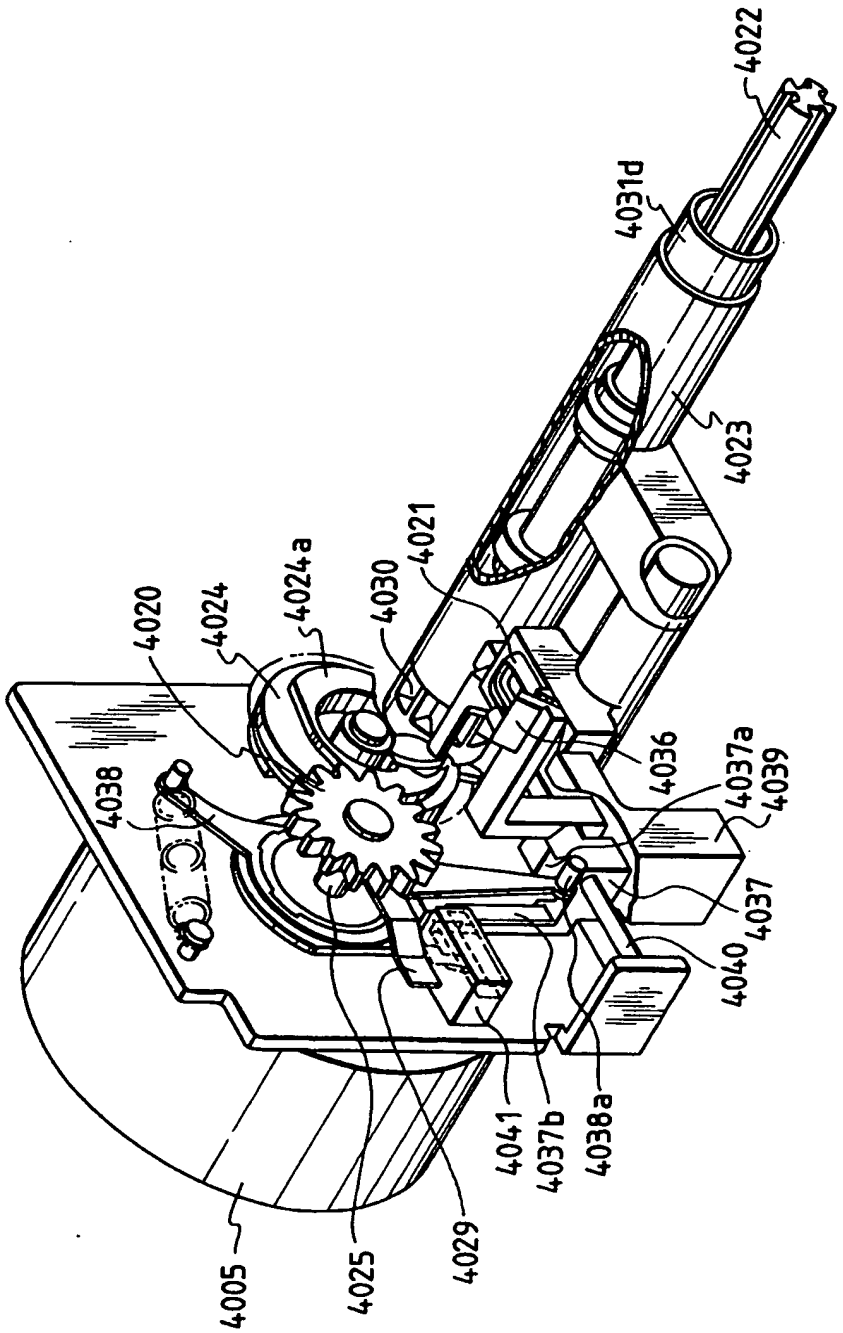
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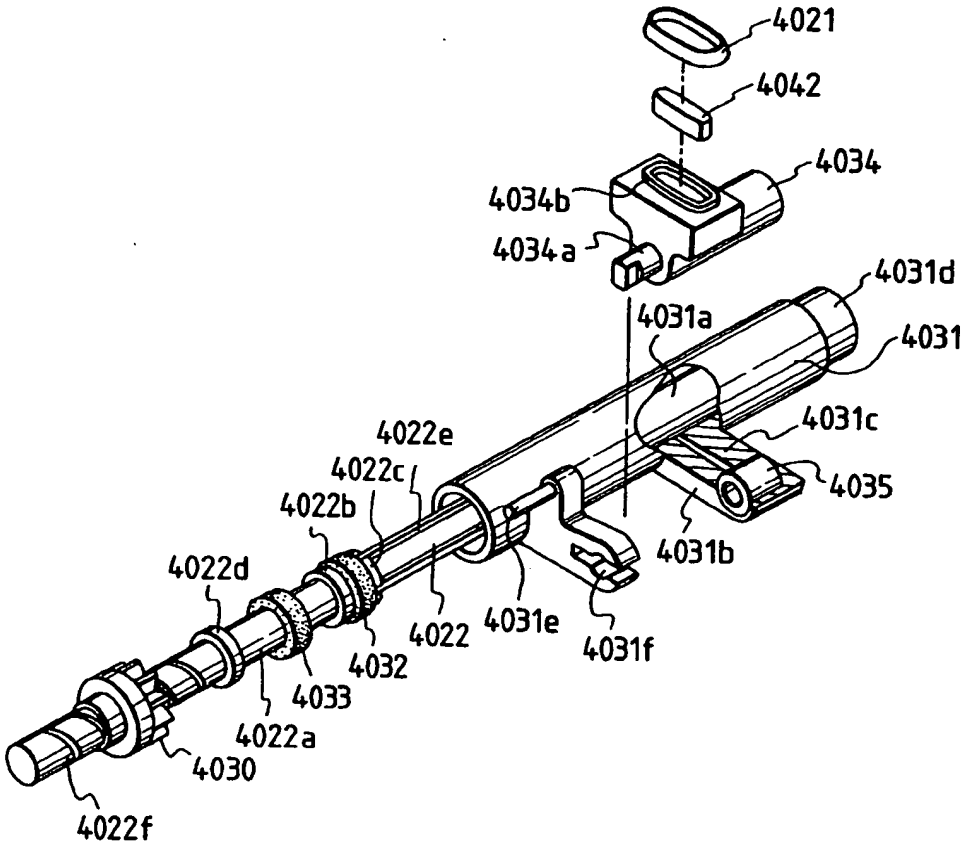
FIG. 9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4034
4034b
4034a
4031d
4031a
4031
4031c
4035
4022e
4022c
4022b
4031b
4022d
4022
4031e
4031f
4032
4033
4022a
4030
4022f

FIG. 10A

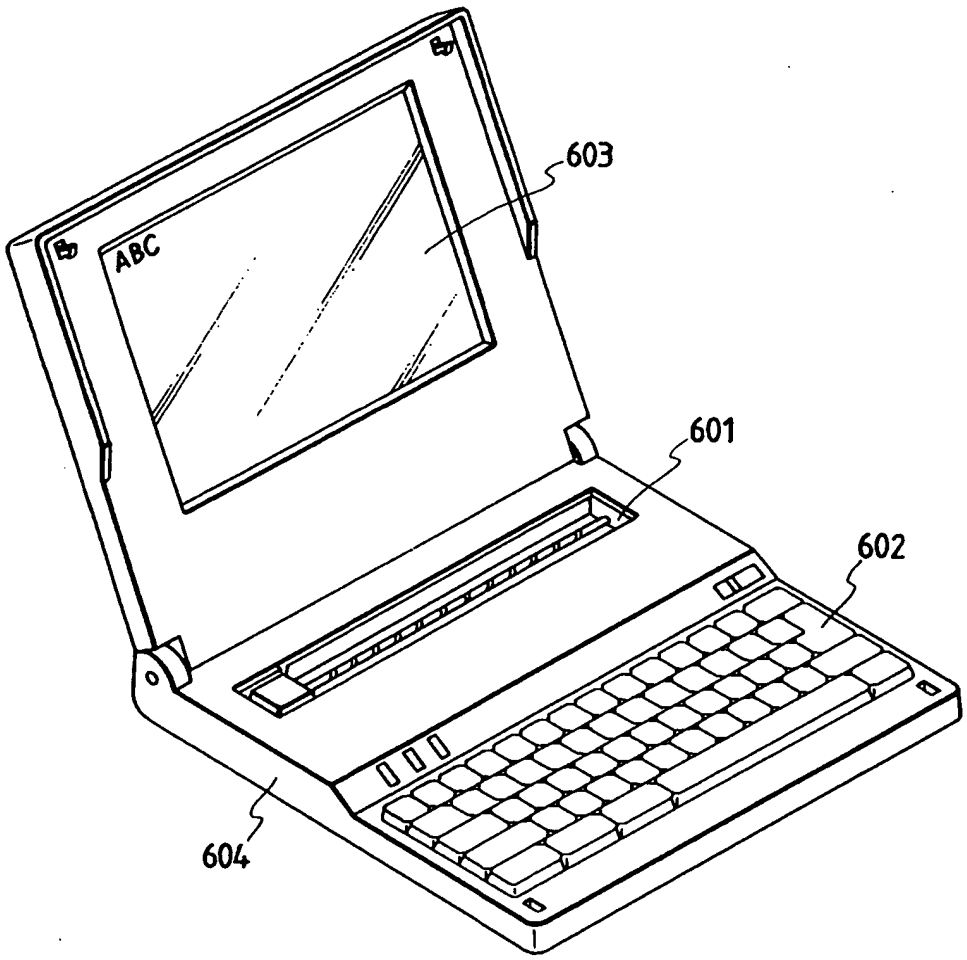


FIG. 10B

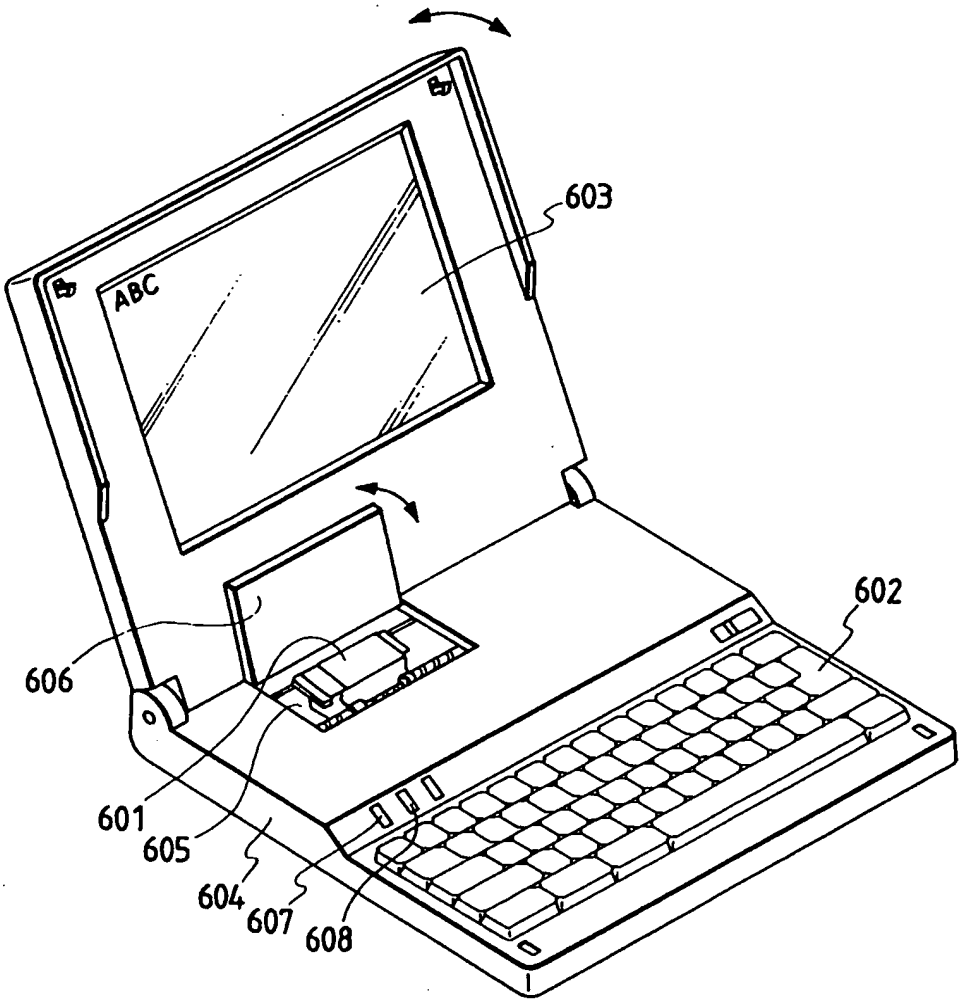


FIG. 11

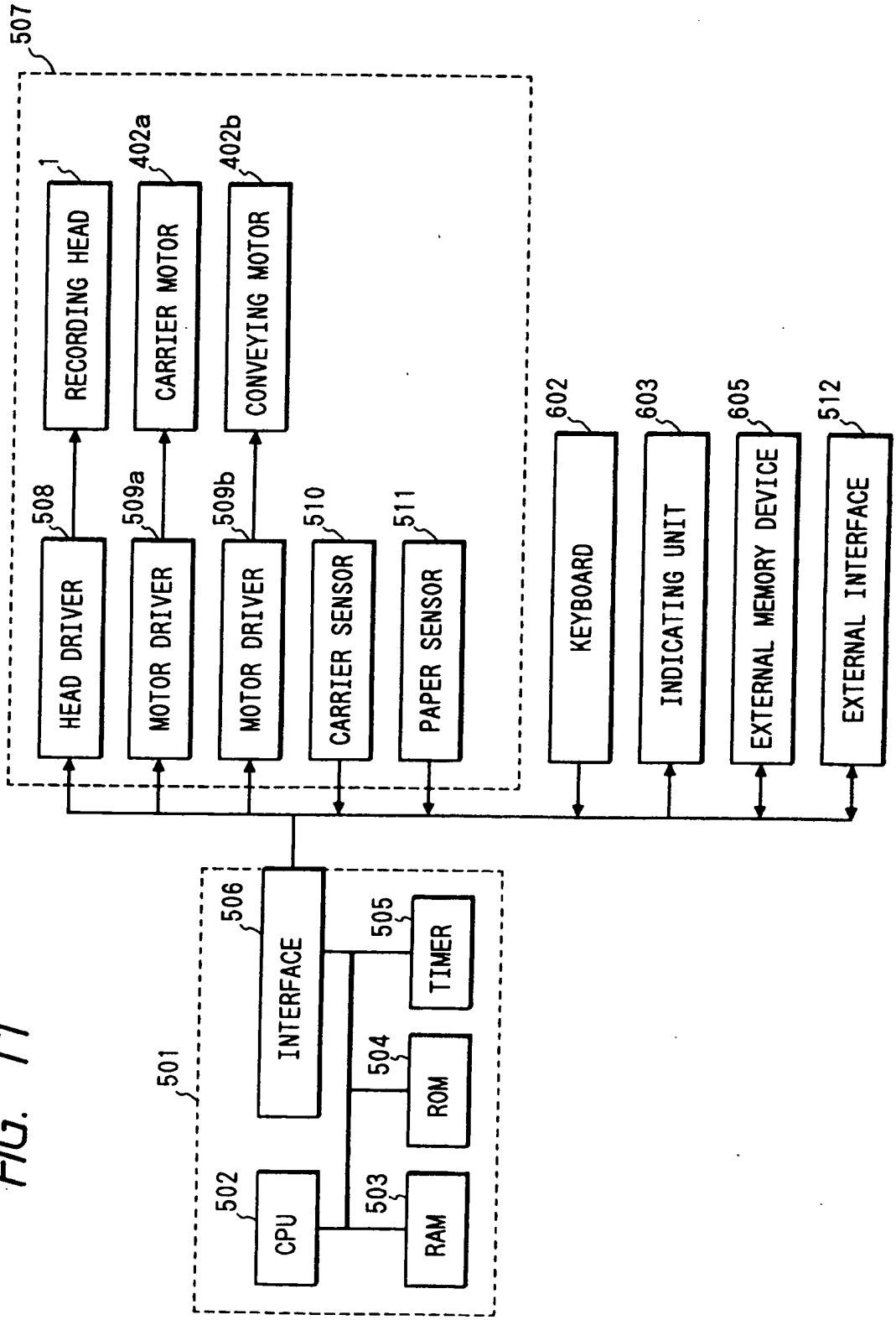

507
1
RECORDING HEAD
402a
CARRIER MOTOR
402b
CONVEYING MOTOR
508
HEAD DRIVER
509a
MOTOR DRIVER
509b
MOTOR DRIVER
510
CARRIER SENSOR
511
PAPER SENSOR
602
KEYBOARD
603
INDICATING UNIT
605
EXTERNAL MEMORY DEVICE
512
EXTERNAL INTERFACE
501
506
INTERFACE
505
TIMER
504
ROM
502
CPU
503
RAM

FIG. 12

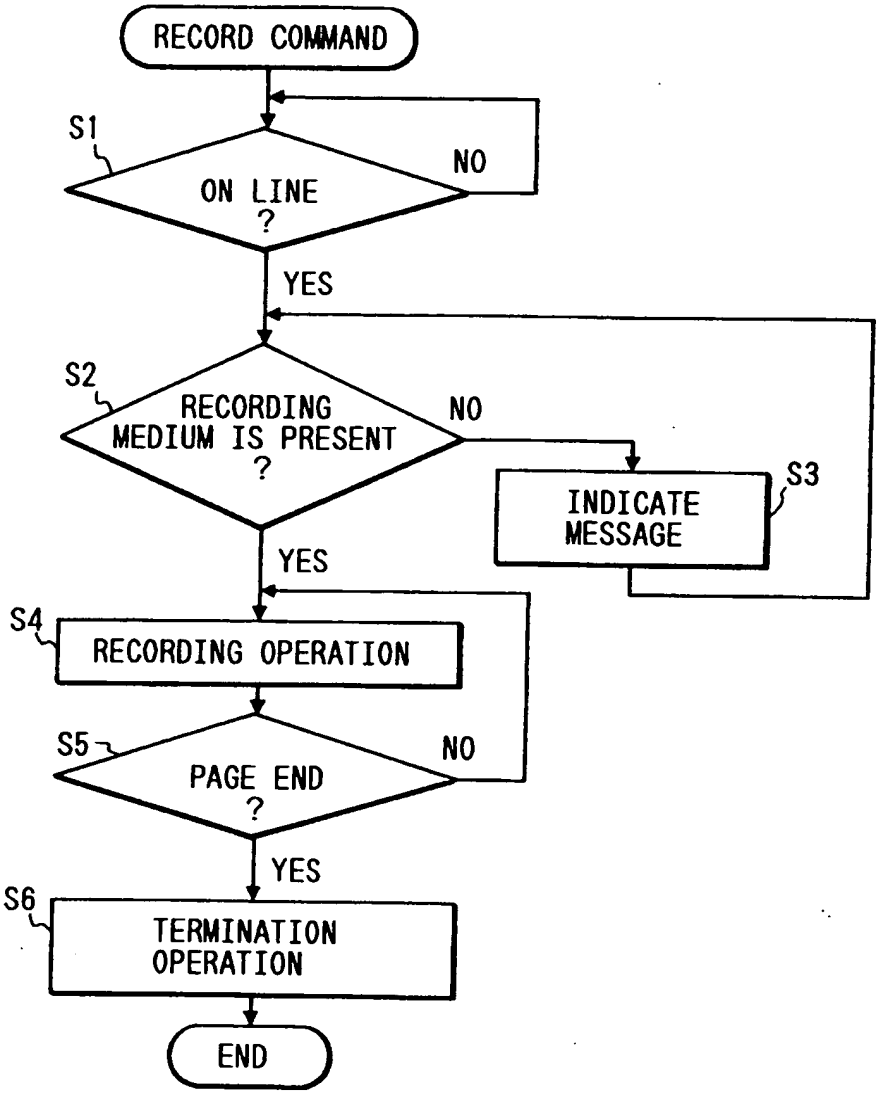

RECORD COMMAND
S1
ON LINE ?
NO
YES
S2
RECORDING MEDIUM IS PRESENT ?
NO
S3
INDICATE MESSAGE
YES
S4
RECORDING OPERATION
S5
PAGE END ?
NO
YES
S6
TERMINATION OPERATION
END

FIG. 13

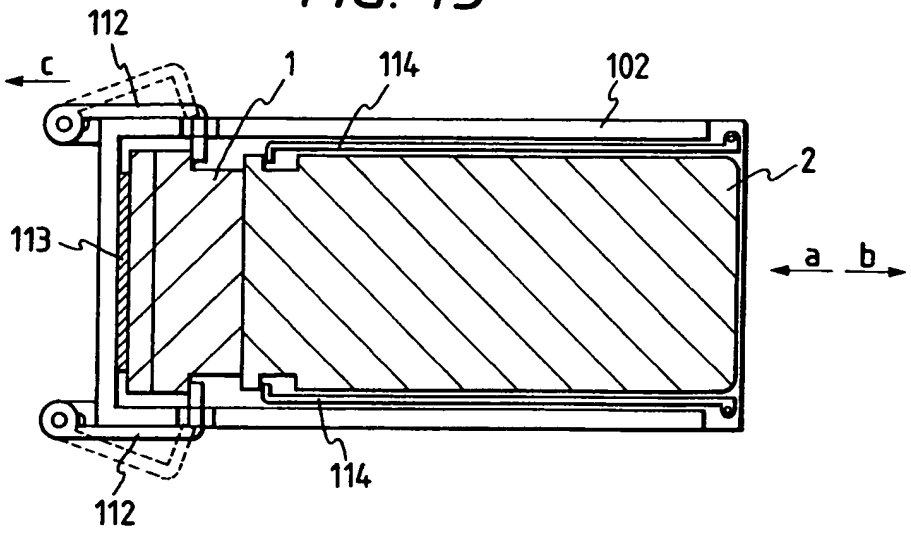


FIG. 14

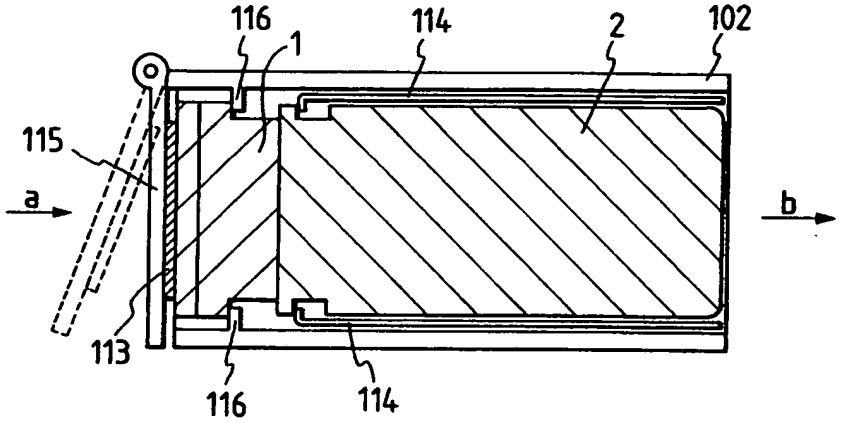


FIG. 16

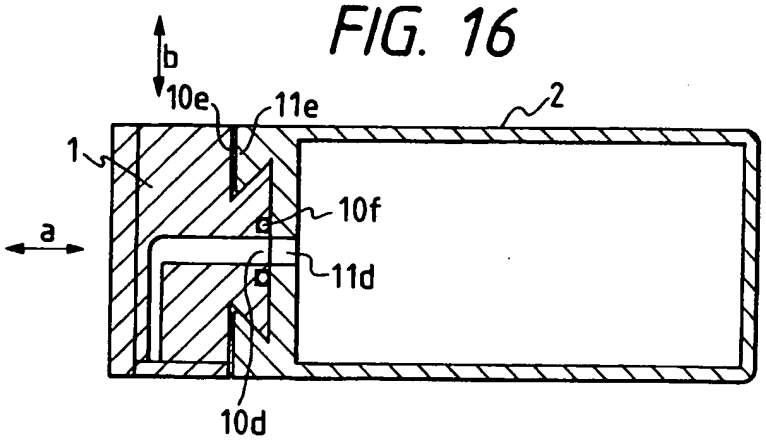


FIG. 15A

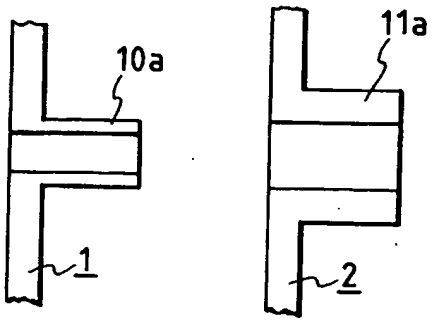


FIG. 15B

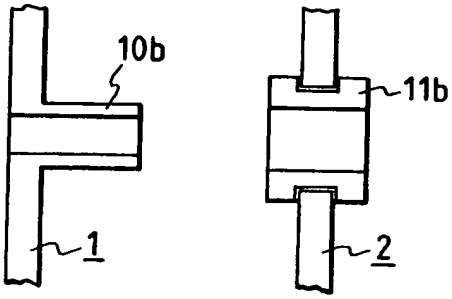


FIG. 15C

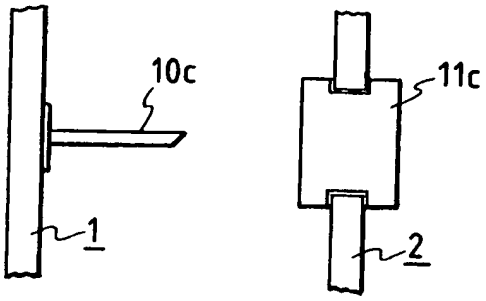


FIG. 17A

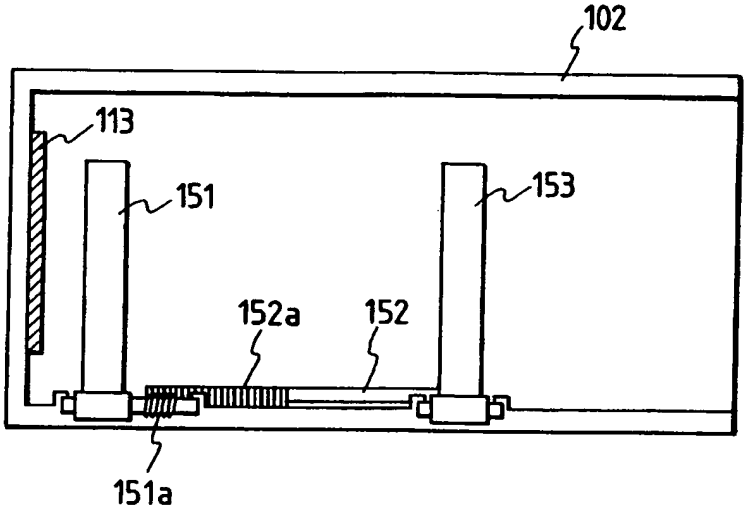


FIG. 17B

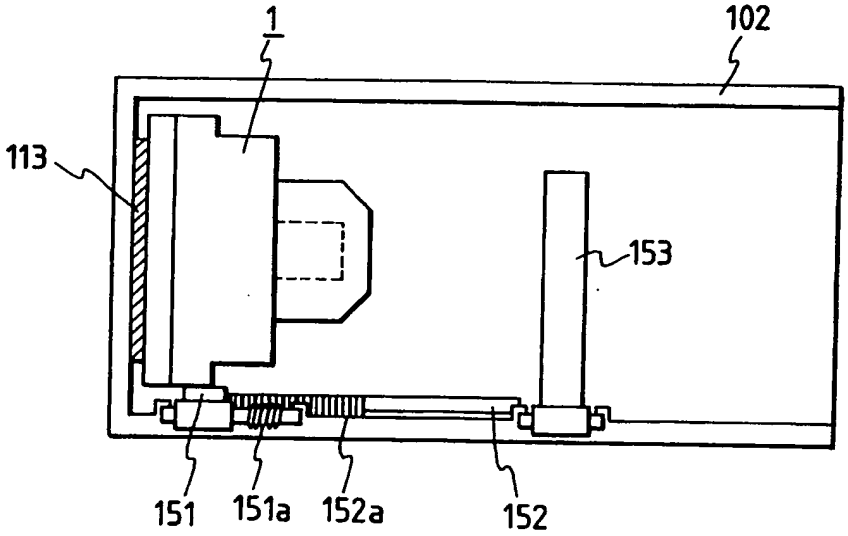


FIG. 18A

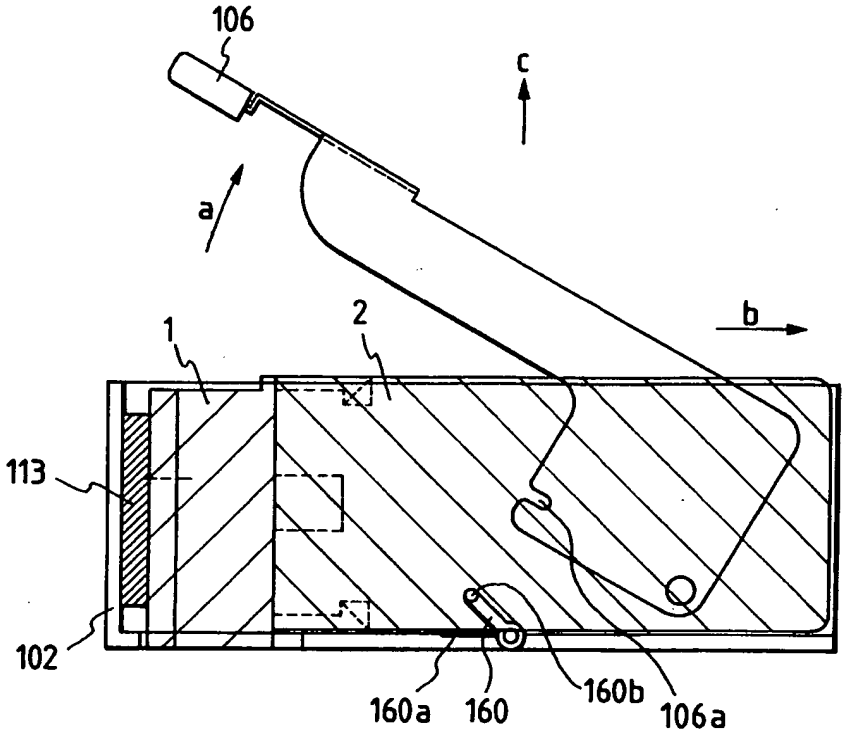


FIG. 18B

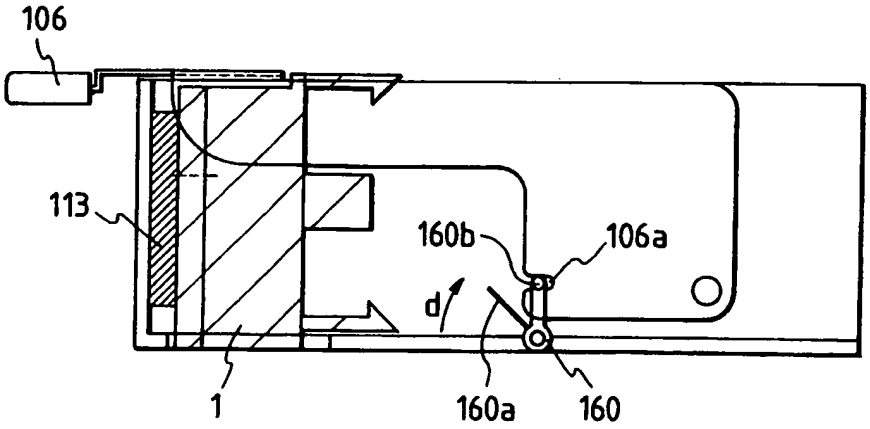


FIG. 19

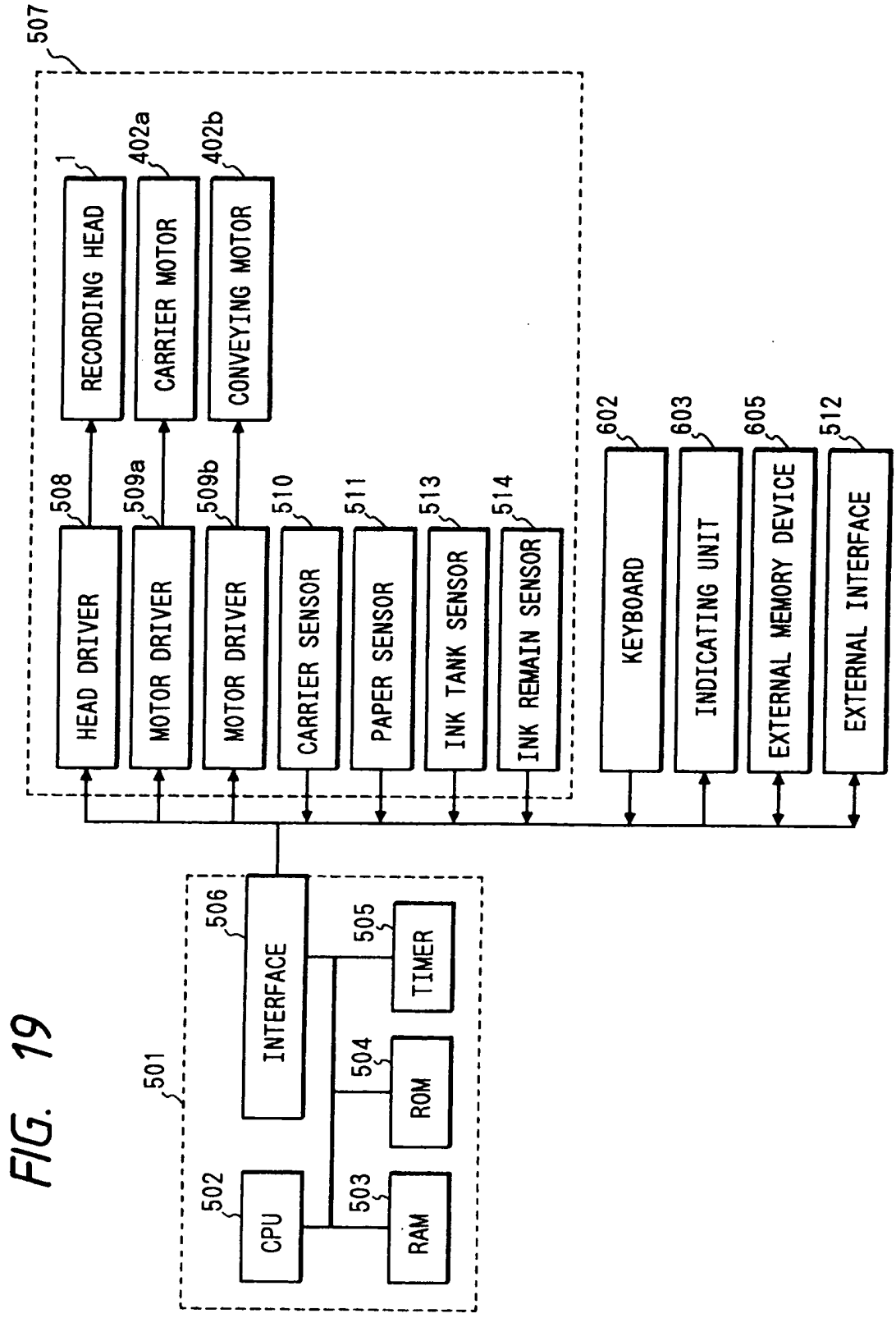

507
1
RECORDING HEAD
402a
CARRIER MOTOR
402b
CONVEYING MOTOR
508
HEAD DRIVER
509a
MOTOR DRIVER
509b
MOTOR DRIVER
510
CARRIER SENSOR
511
PAPER SENSOR
513
INK TANK SENSOR
514
INK REMAIN SENSOR
602
KEYBOARD
603
INDICATING UNIT
605
EXTERNAL MEMORY DEVICE
512
EXTERNAL INTERFACE
501
506
INTERFACE
505
TIMER
504
ROM
502
CPU
503
RAM

FIG. 20

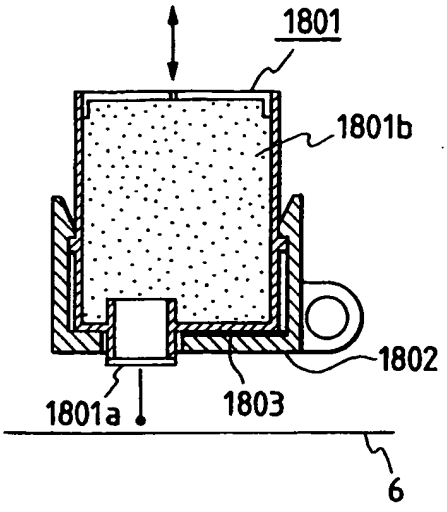


FIG. 22

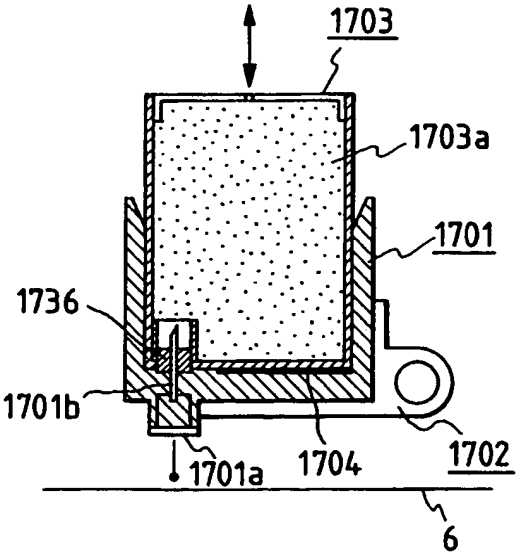


FIG. 21

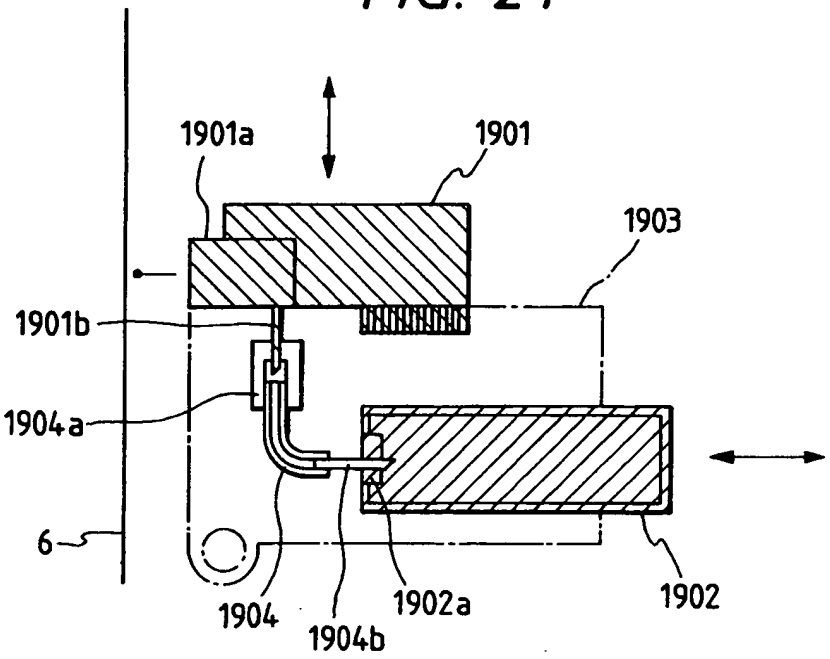


FIG. 23

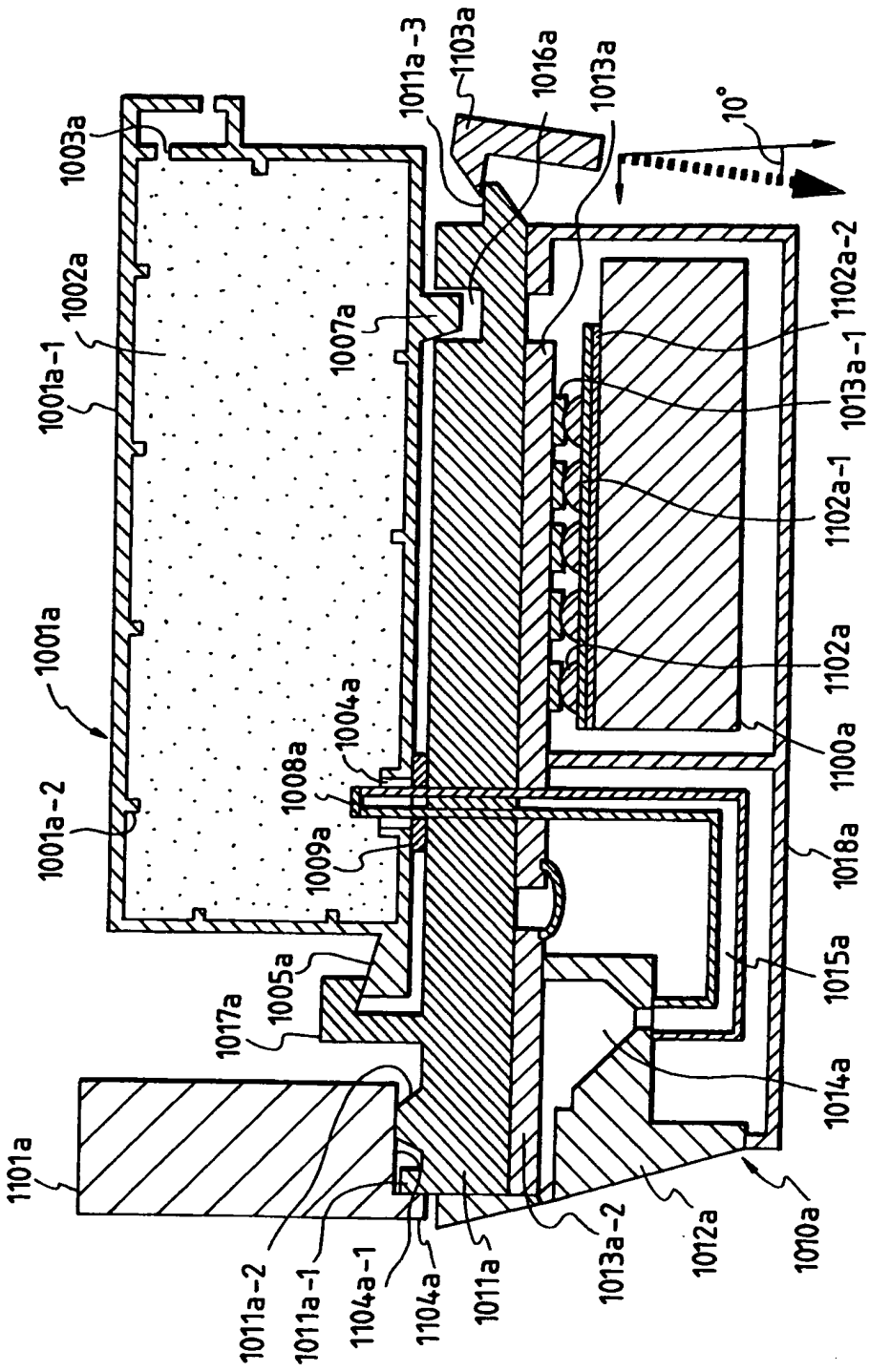

1003a
1002a
1001a-1
1001a
1001a-2
1007a
1008a
1004a
1009a
1005a
1017a
1101a
1011a-2
1011a-1
1104a-1
1104a
1011a
1011a-3
1103a
1016a
1013a
10°
1013a-2
1012a
1010a
1102a-2
1013a-1
1102a-1
1102a
1100a
1018a
1015a
1014a

FIG. 24

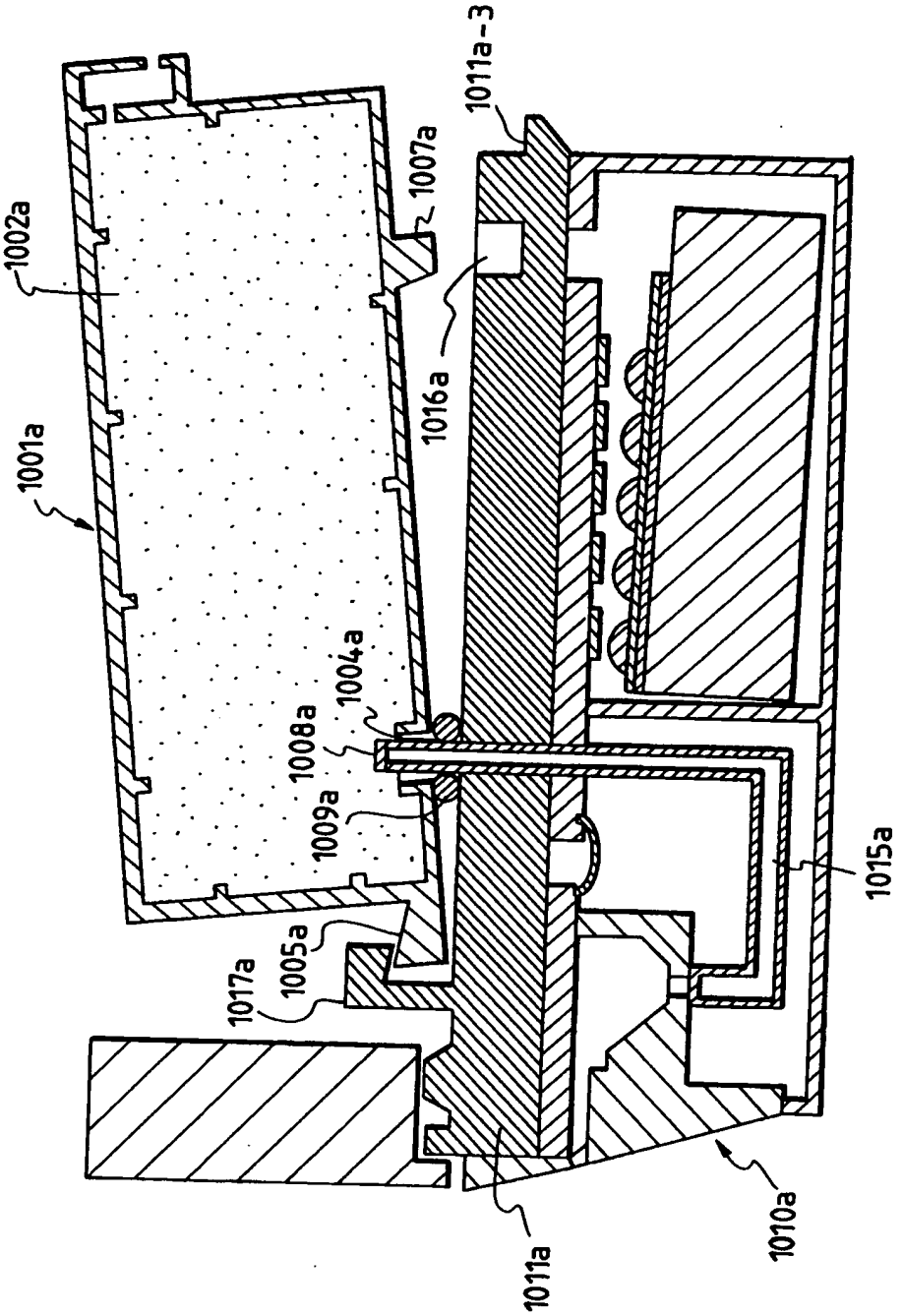

1011a-3
1007a
1002a
1016a
1001a
1004a
1008a
1009a
1015a
1005a
1017a
1011a
1010a

FIG. 25

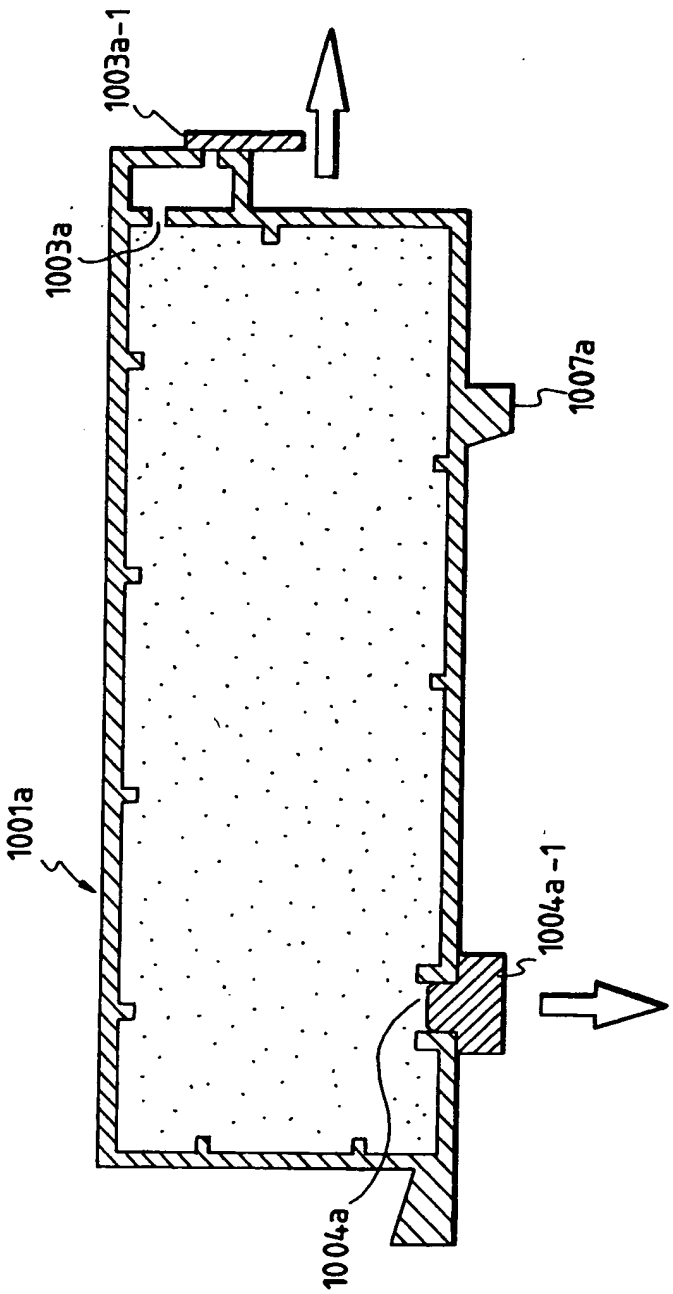


FIG. 26

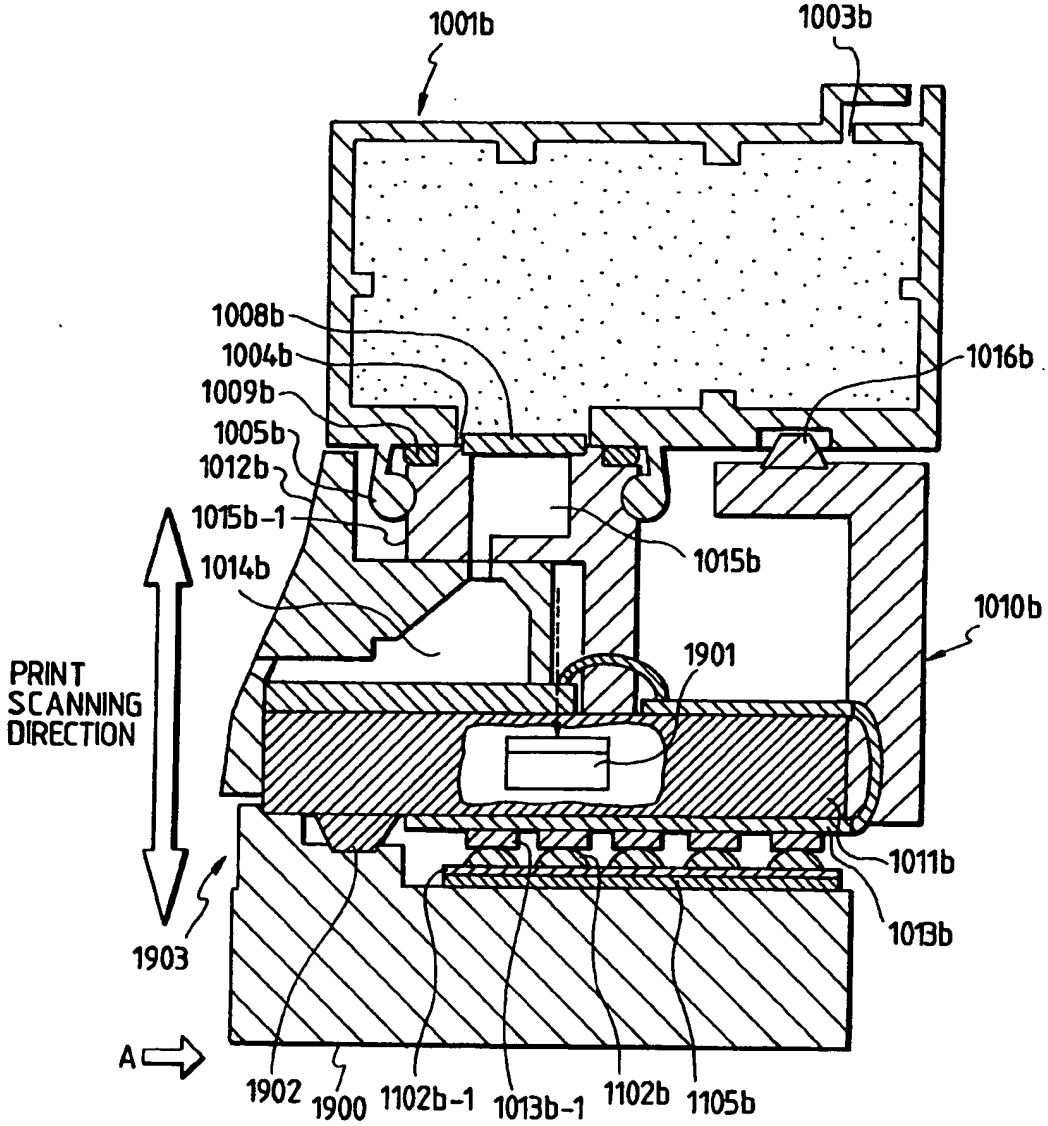

1001b
1003b
1008b
1004b
1009b
1005b
1012b
1015b-1
1014b
1016b
1015b
1010b
1901
PRINT
SCANNING
DIRECTION
1011b
1013b
1903
A
1902
1900
1102b-1
1013b-1
1102b
1105b

FIG. 27

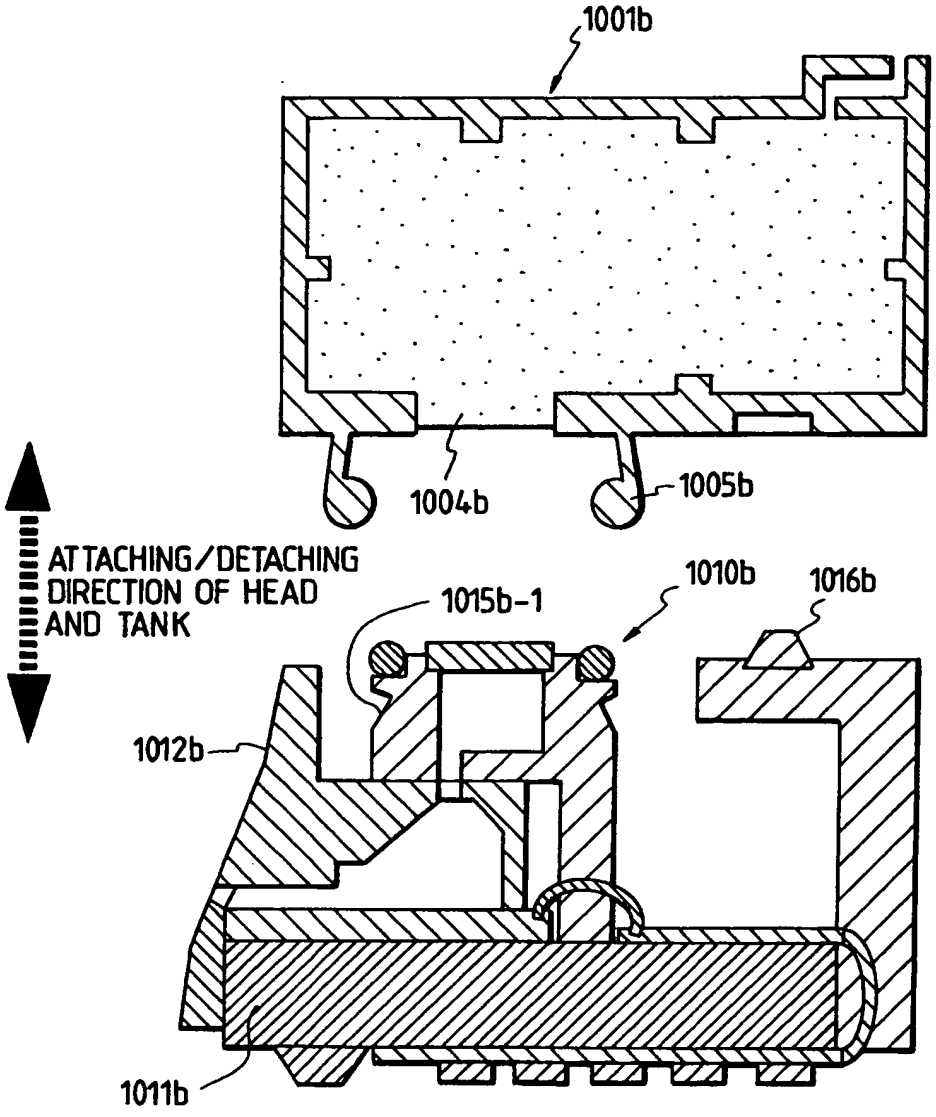

1001b
1004b
1005b
ATTACHING/DETACHING
DIRECTION OF HEAD
AND TANK
1015b-1
1010b
1016b
1012b
1011b

FIG. 28

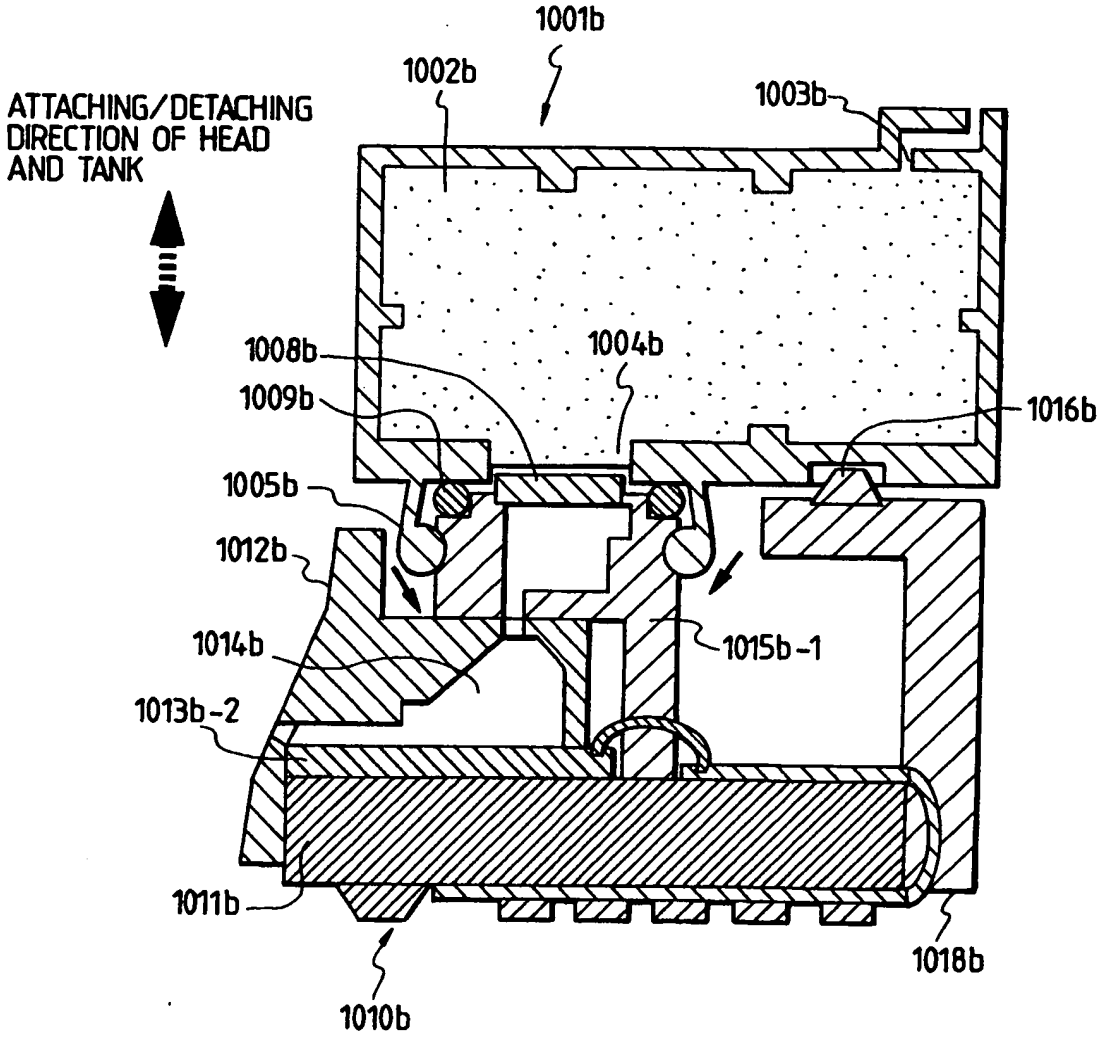

1001b
1002b
1003b
ATTACHING/DETACHING
DIRECTION OF HEAD
AND TANK
1008b
1004b
1009b
1016b
1005b
1012b
1014b
1015b-1
1013b-2
1011b
1018b
1010b

FIG. 29

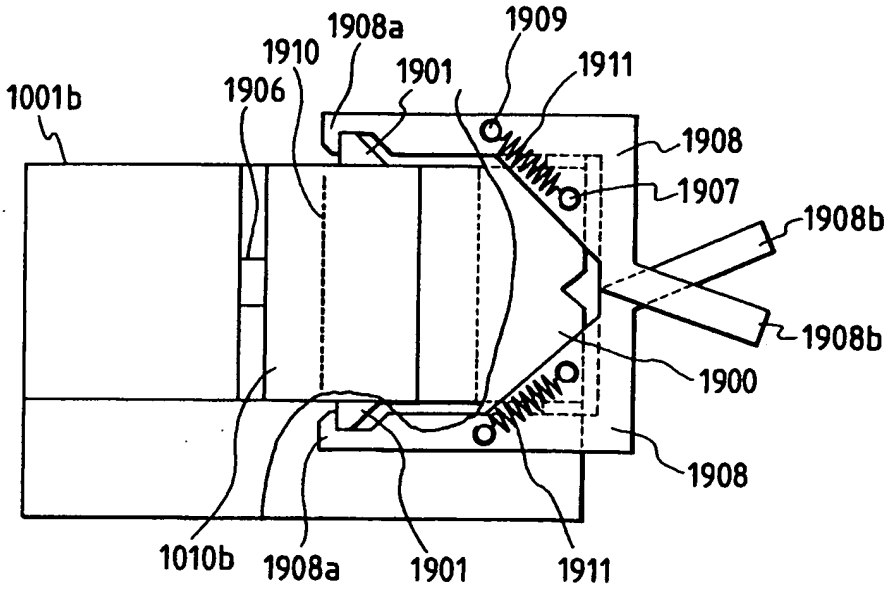

1001b
1910
1908a
1906
1901
1909
1911
1908
1907
1908b
1908b
1900
1908
1010b
1908a
1901
1911

FIG. 31

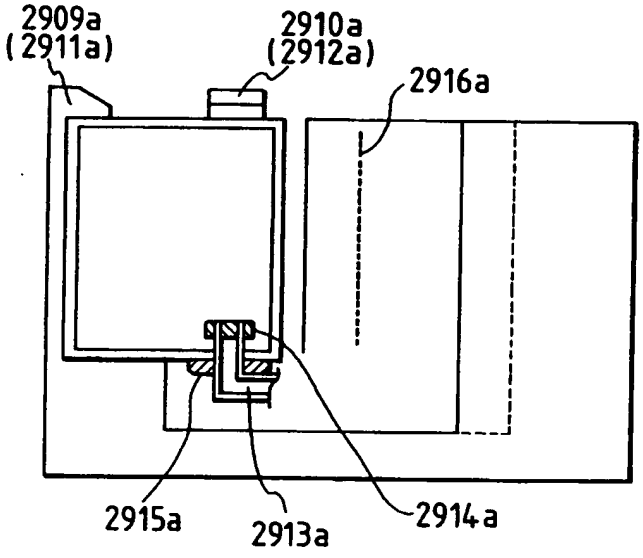

2909a
(2911a)
2910a
(2912a)
2916a
2915a
2913a
2914a

FIG. 30

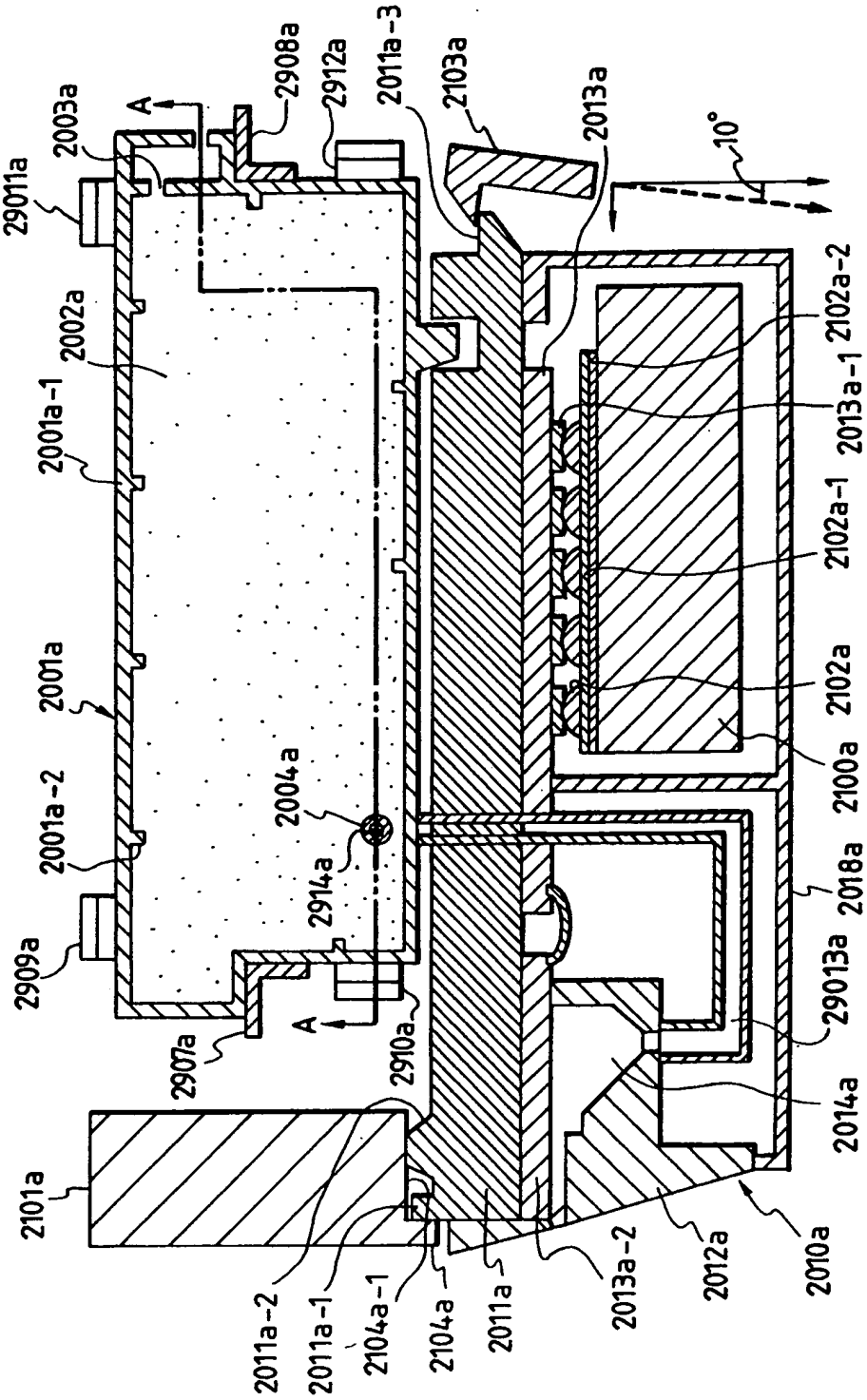

29011a
2003a
A
2908a
2912a
2011a-3
2103a
2013a
10°
2002a
2001a-1
2102a-2
2013a-1
2102a-1
2001a
2102a
2001a-2
2004a
2914a
2100a
2018a
2909a
29013a
A
2907a
2910a
2014a
2101a
2011a-2
2011a-1
2104a-1
2104a
2011a
2013a-2
2012a
2010a

FIG. 32

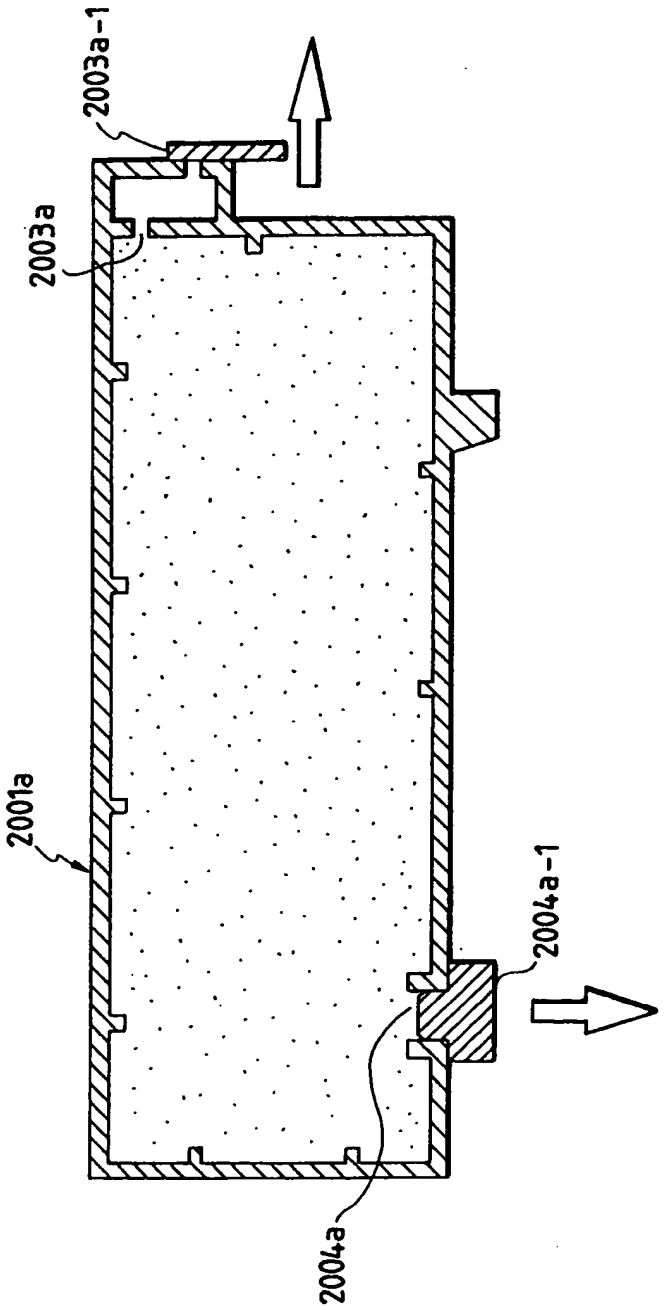


FIG. 33

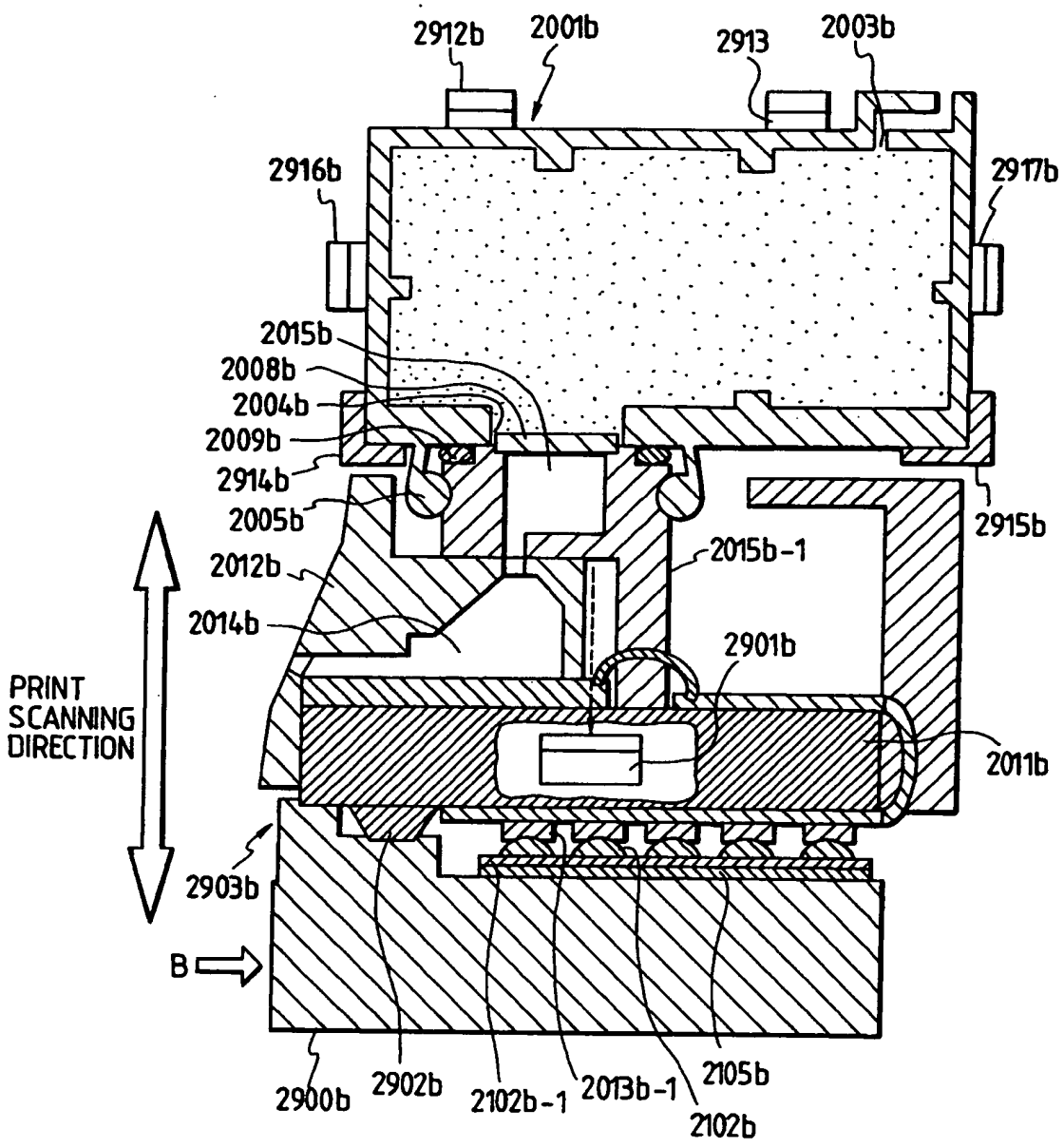

2912b
2001b
2913
2003b
2916b
2917b
2015b
2008b
2004b
2009b
2914b
2005b
2012b
2014b
2915b
2015b-1
2901b
2011b
PRINT SCANNING DIRECTION
2903b
B
2900b
2902b
2102b-1
2013b-1
2105b
2102b

FIG. 34

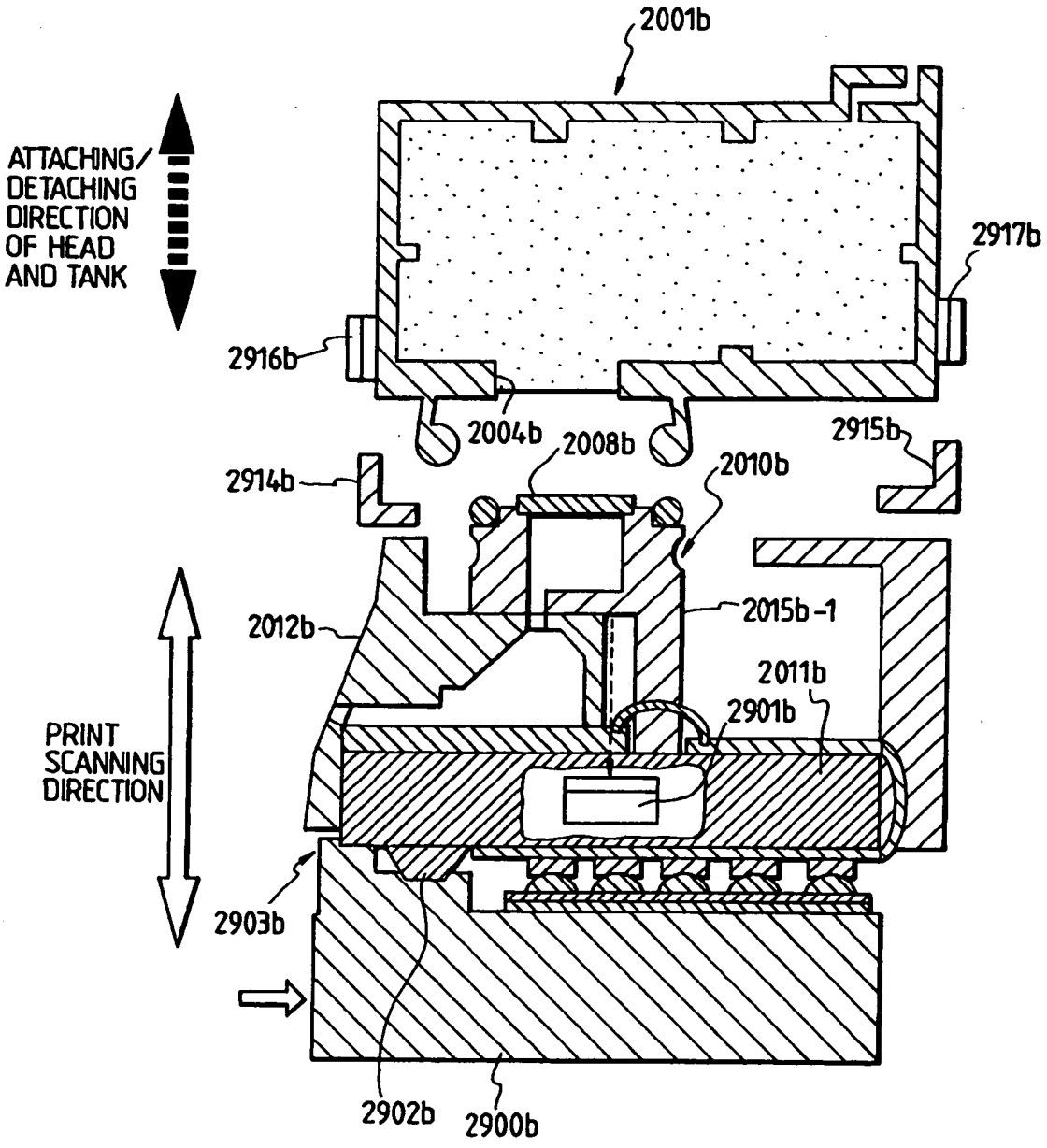

2001b
ATTACHING/
DETACHING
DIRECTION
OF HEAD
AND TANK
2917b
2916b
2004b
2008b
2915b
2914b
2010b
2012b
2015b-1
2011b
2901b
PRINT
SCANNING
DIRECTION
2903b
2902b
2900b

FIG. 35

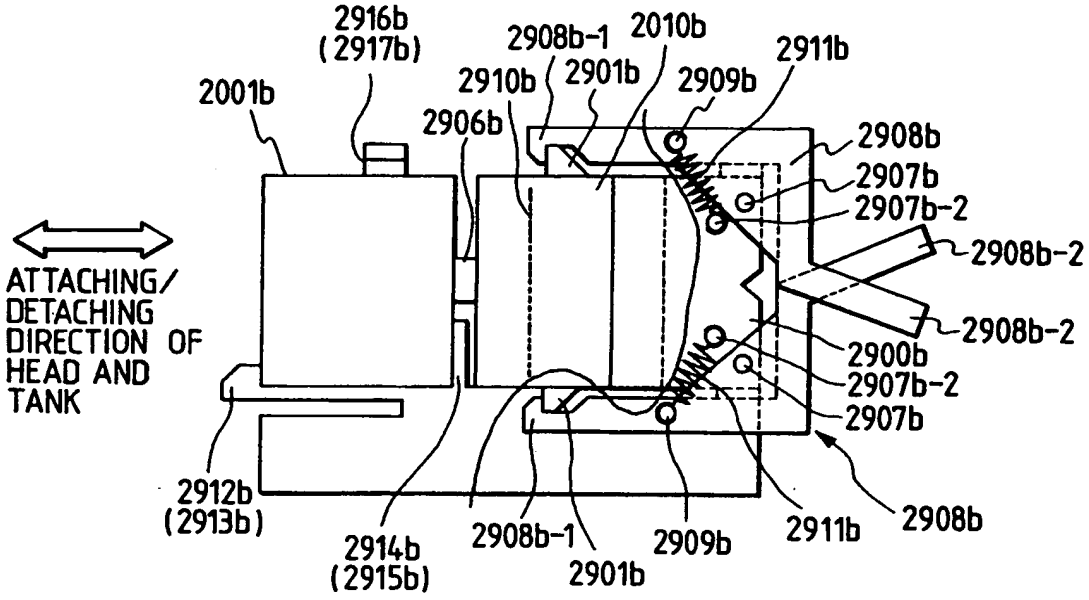

2916b
(2917b)
2908b-1
2010b
2911b
2910b
2901b
2909b
2001b
2906b
2908b
2907b
2907b-2
2908b-2
ATTACHING/
DETACHING
DIRECTION OF
HEAD AND
TANK
2908b-2
2900b
2907b-2
2907b
2912b
(2913b)
2914b
(2915b)
2908b-1
2909b
2911b
2908b
2901b

FIG. 36

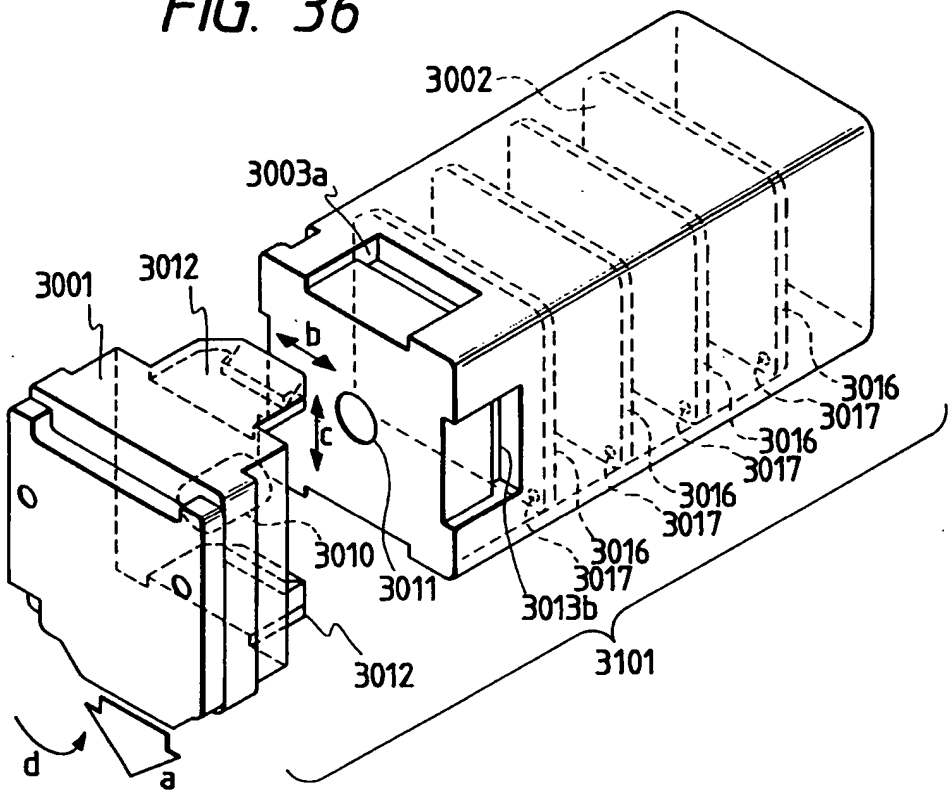

3002
3003a
3001
3012
b
c
3016
3017
3016
3017
3016
3017
3016
3017
3010
3011
3013b
3012
3101
d
a

FIG. 37

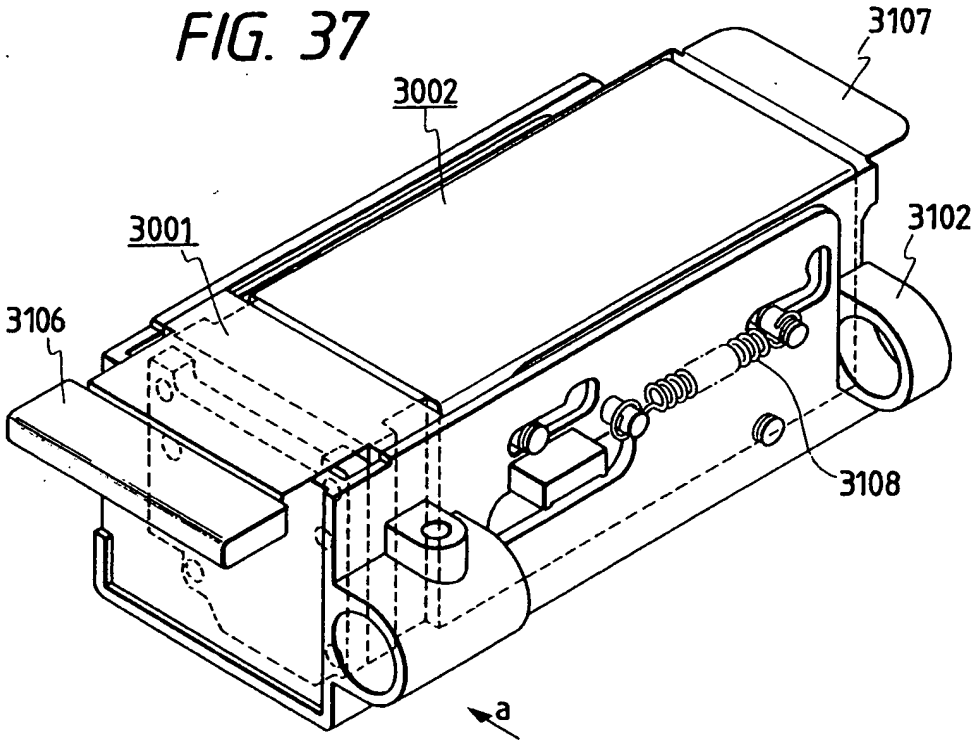

3107
3002
3001
3102
3106
3108
a

FIG. 38

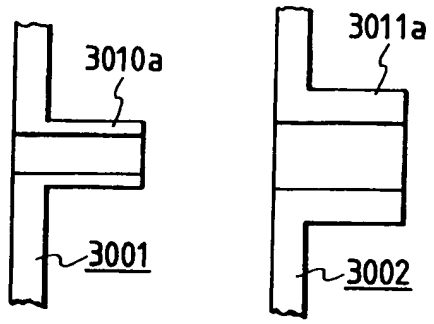


FIG. 39A

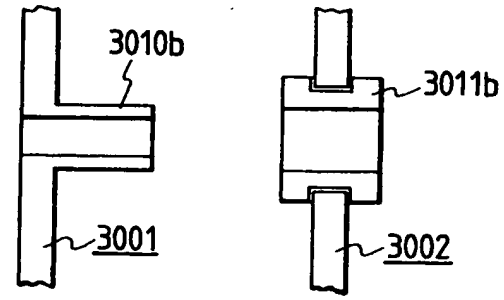


FIG. 39B

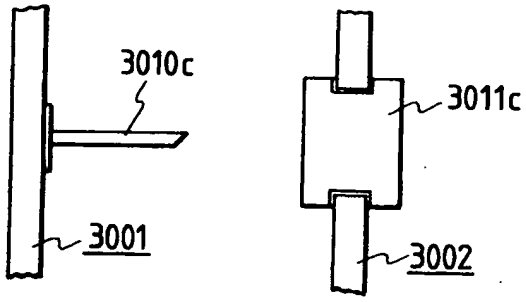


FIG. 40

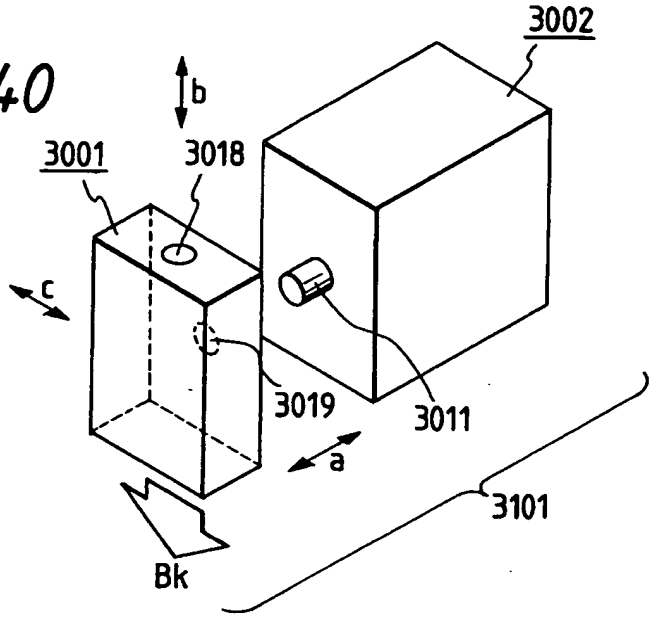

3002
b
3001
3018
c
3019
3011
a
3101
Bk

FIG. 41

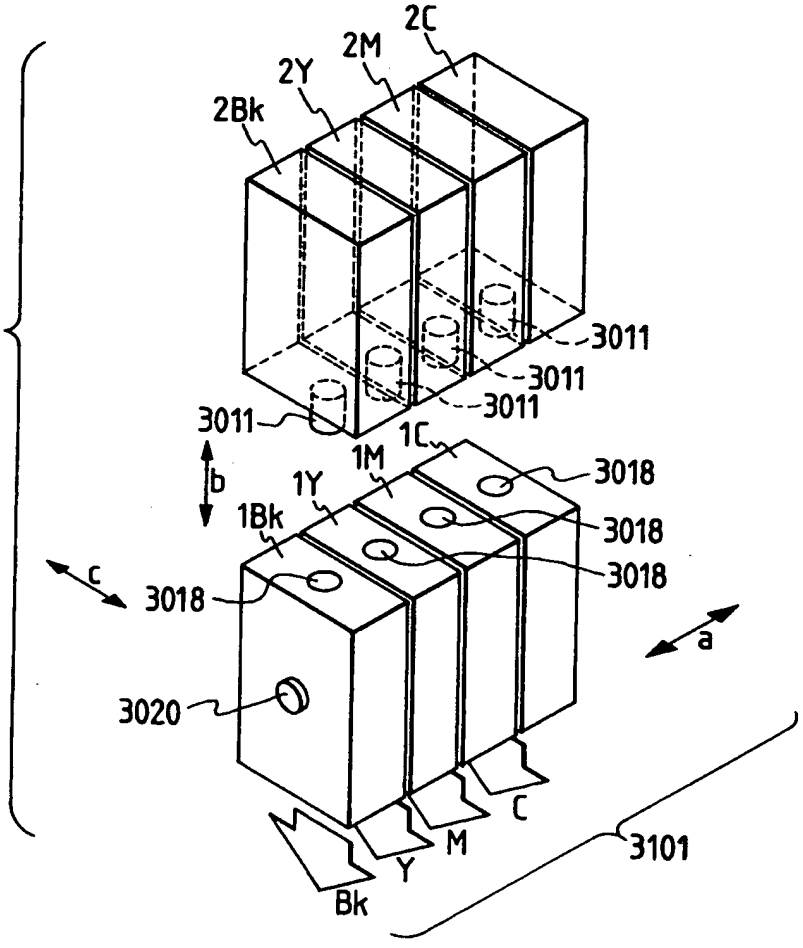
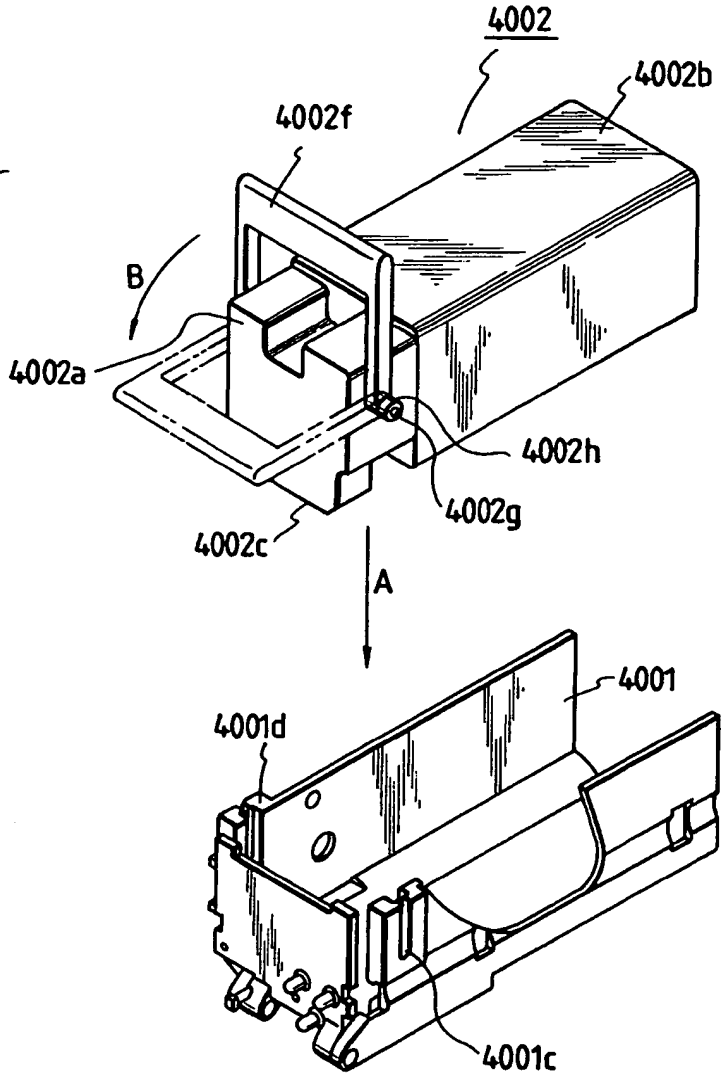

2C
2M
2Y
2Bk
3011
3011
3011
3011
1C
1M
1Y
1Bk
b
3018
3018
3018
3018
c
a
3020
C
M
Y
Bk
3101

FIG. 42


4002
4002b
4002f
B
4002a
4002h
4002g
4002c
A
4001
4001d
4001c

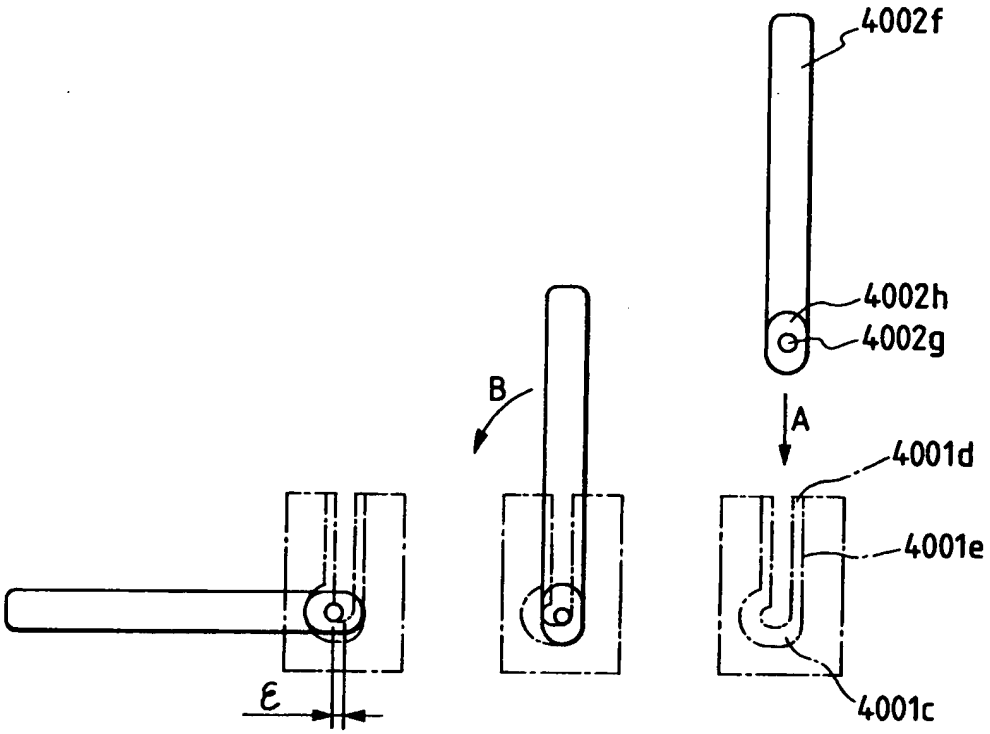


FIG. 43

FIG. 44

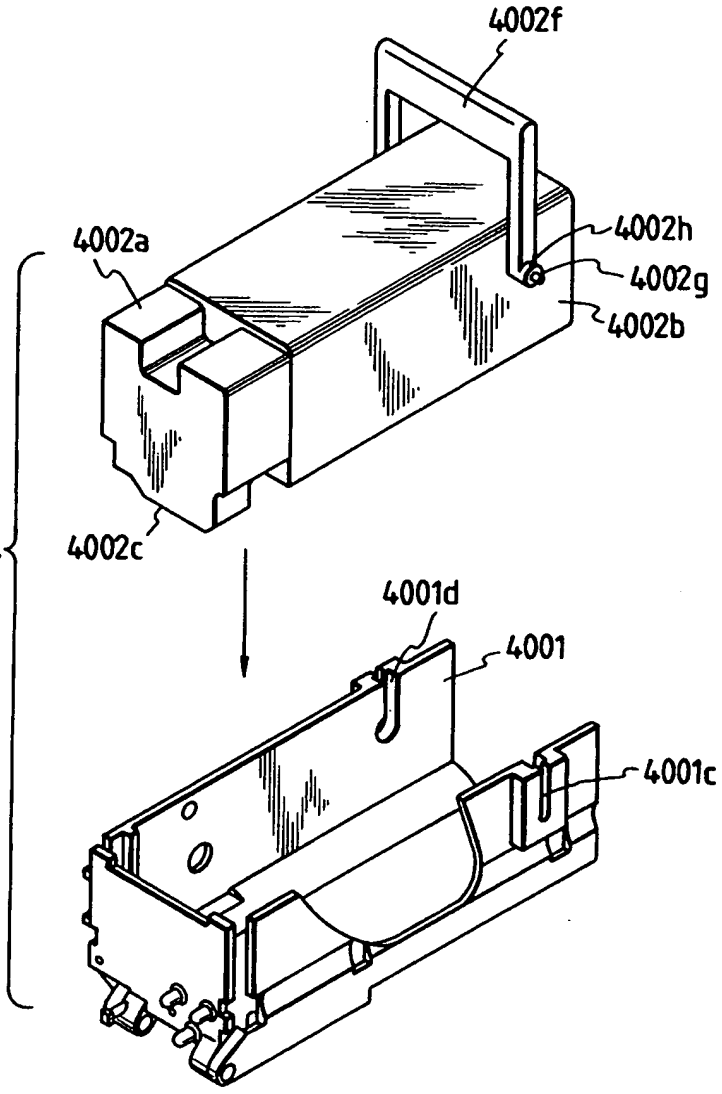


FIG. 45

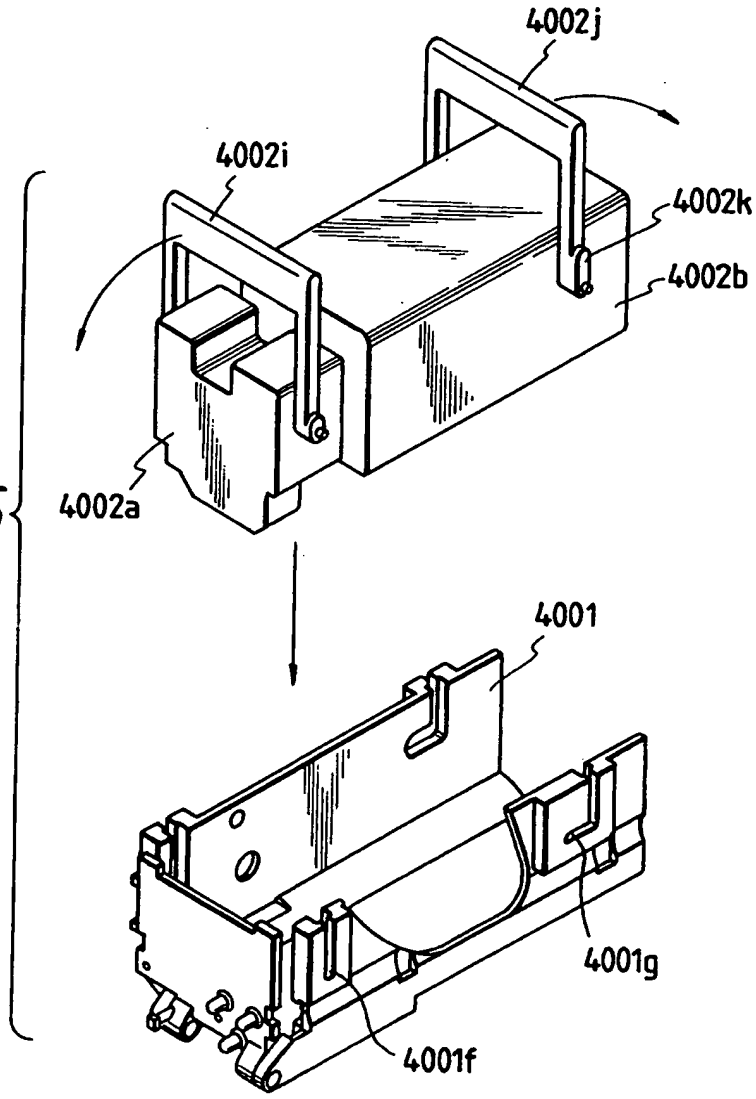


FIG. 46

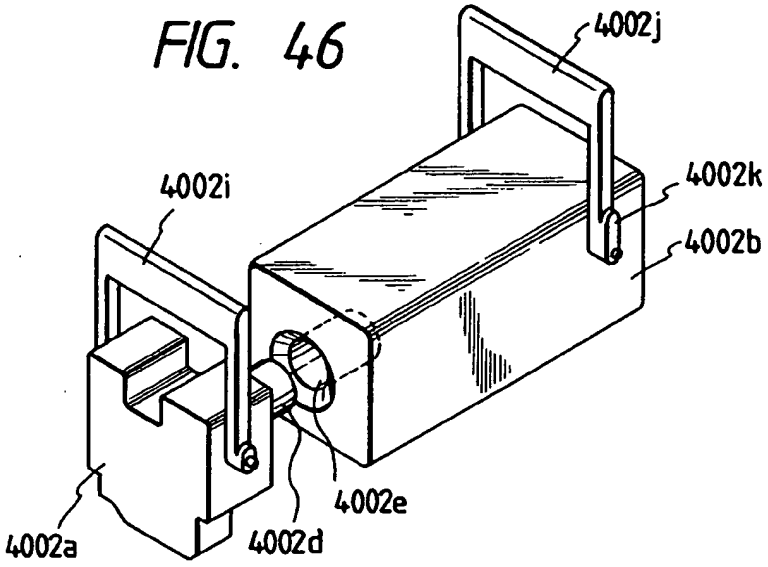

4002j
4002k
4002i
4002b
4002e
4002a
4002d

FIG. 47

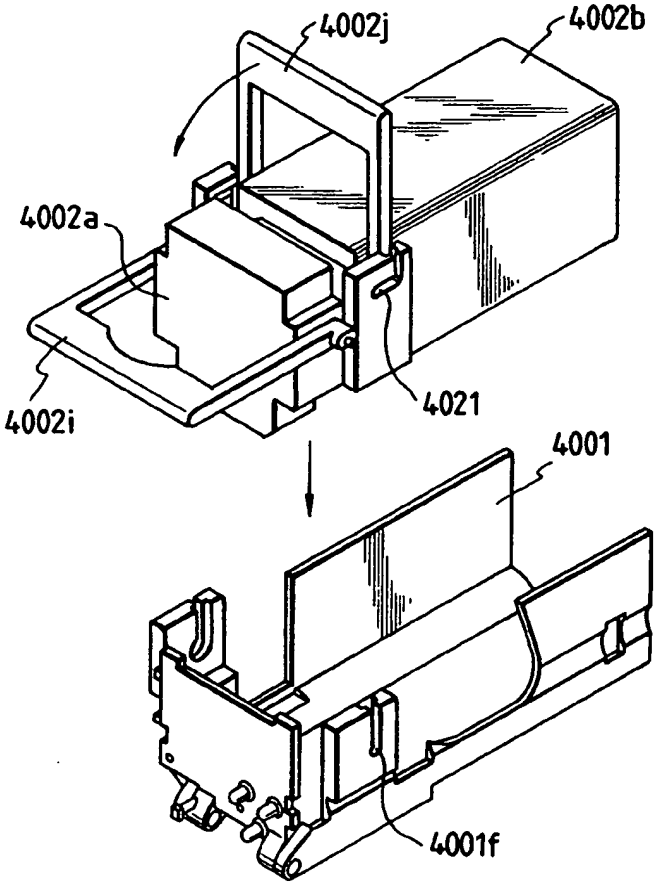

4002j
4002b
4002a
4002i
4021
4001
4001f

FIG. 48

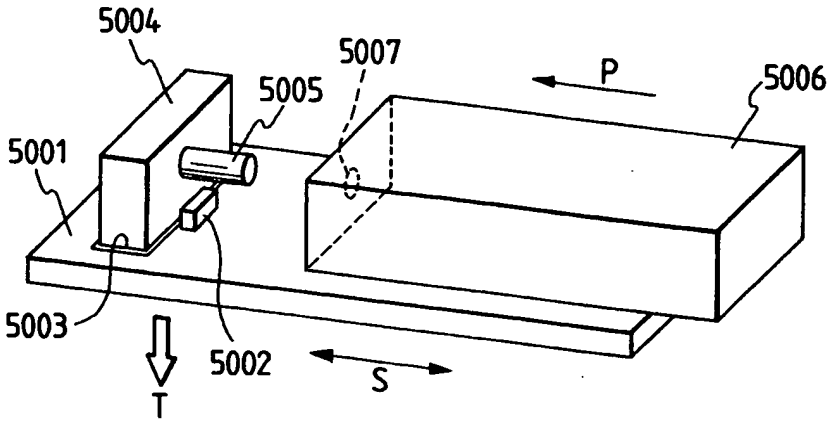

5004
5007
5005
P
5006
5001
5003
5002
S
T

FIG. 49

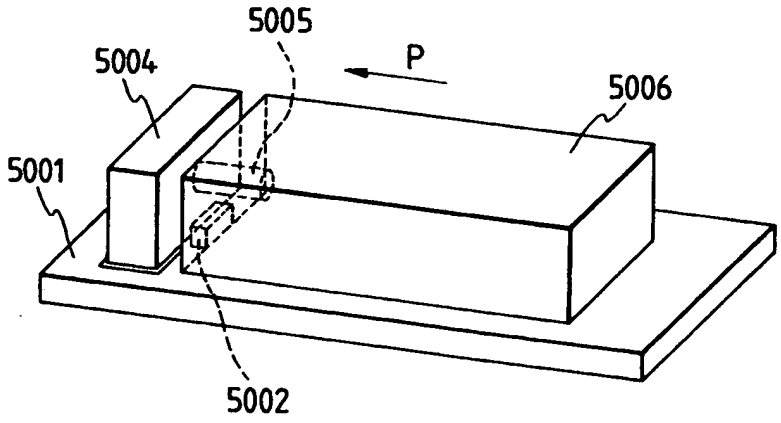

5005
5004
P
5006
5001
5002

FIG. 50

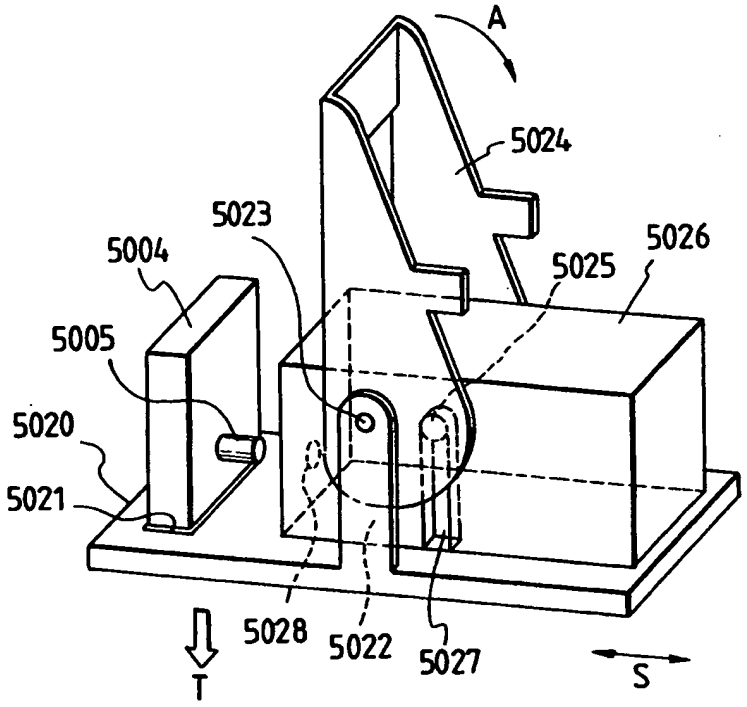

A
5024
5023
5004
5026
5025
5005
5020
5021
5028
5022
5027
T
S

FIG. 51

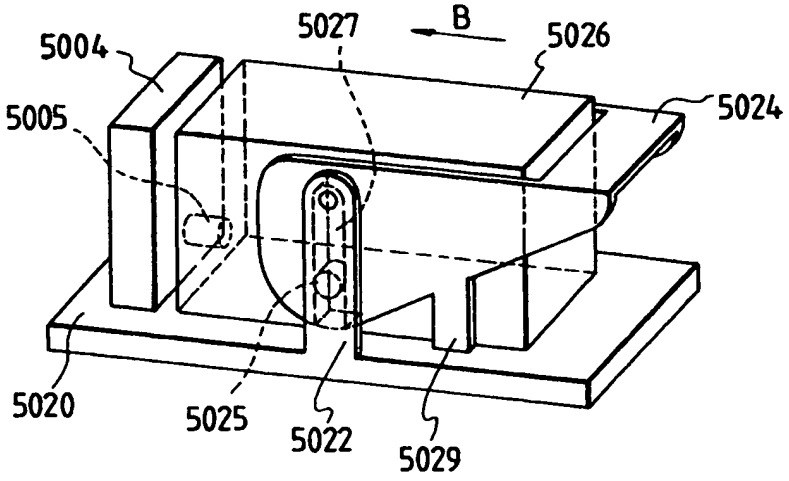

5027
B
5026
5004
5024
5005
5020
5025
5022
5029

FIG. 52

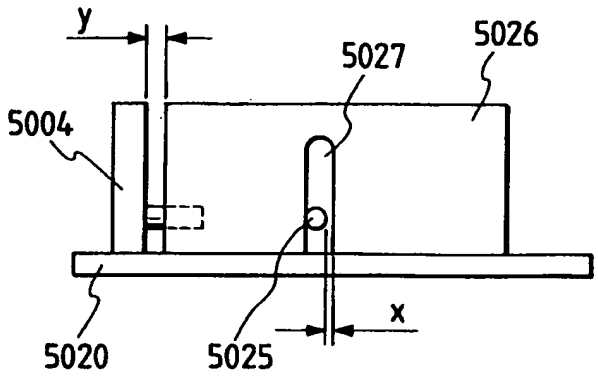


FIG. 53

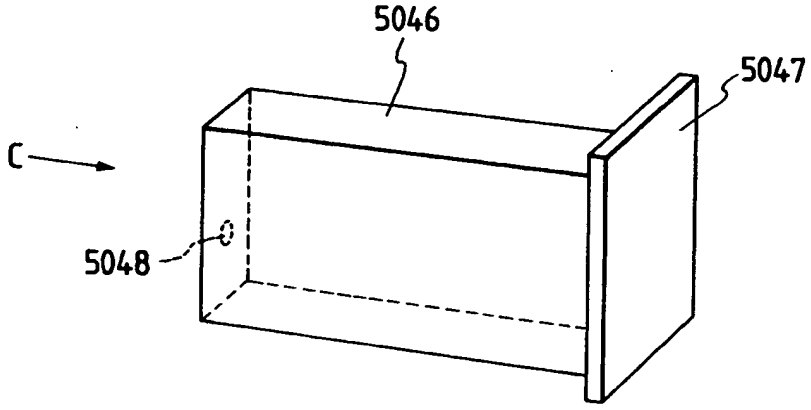


FIG. 54

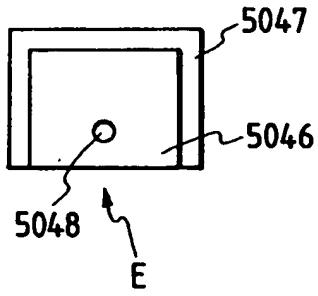


FIG. 55

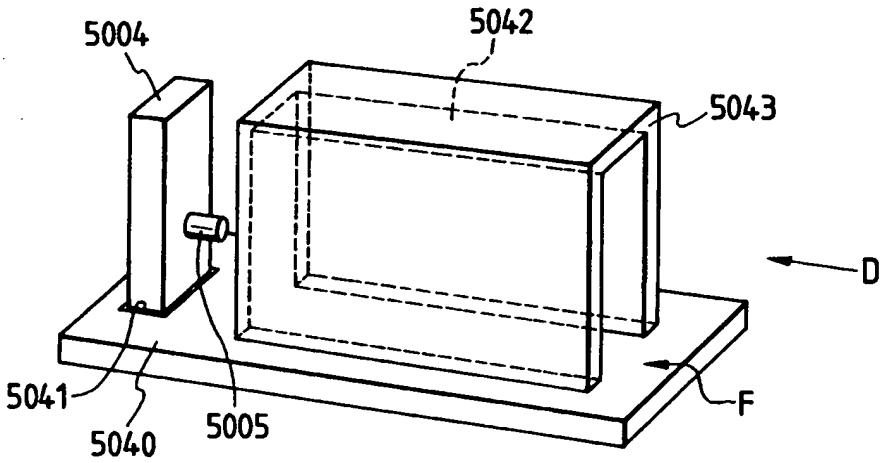


FIG. 56

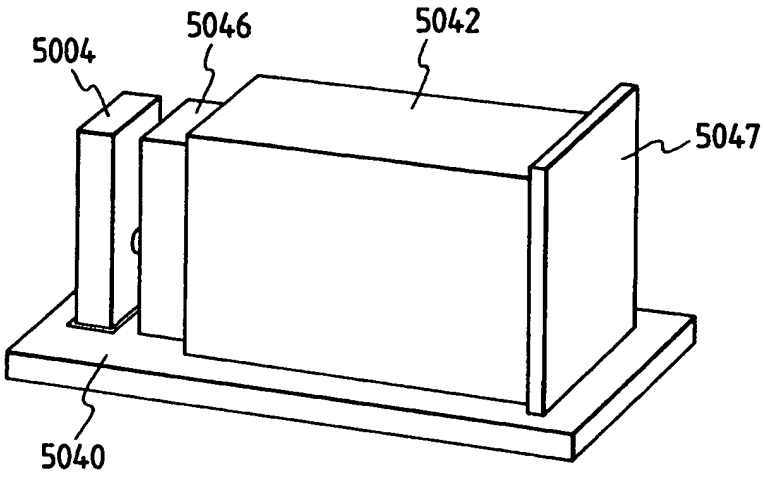


FIG. 57

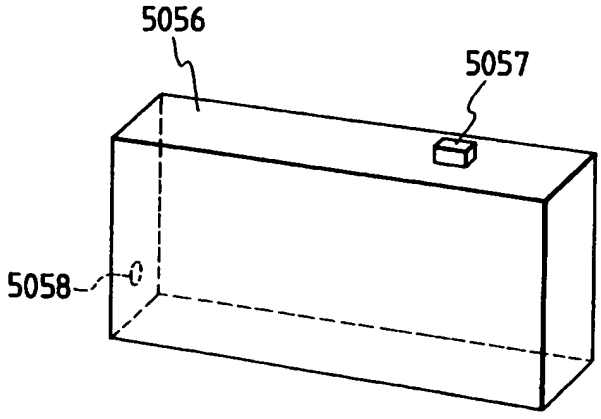


FIG. 58

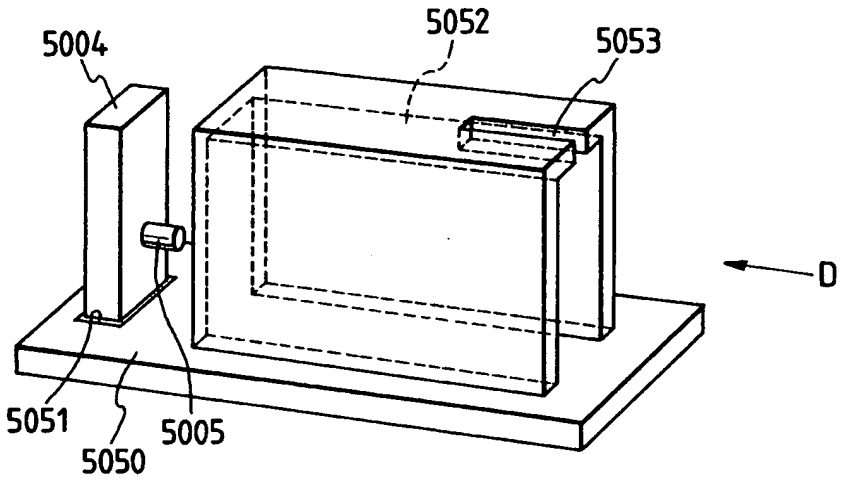


FIG. 59

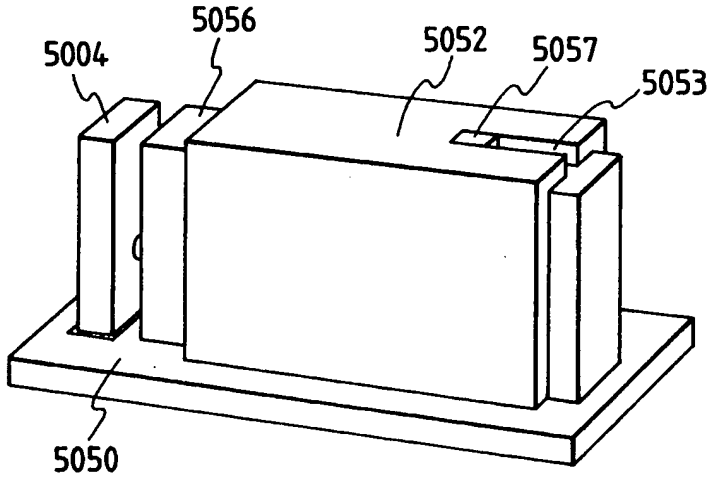


FIG. 60A

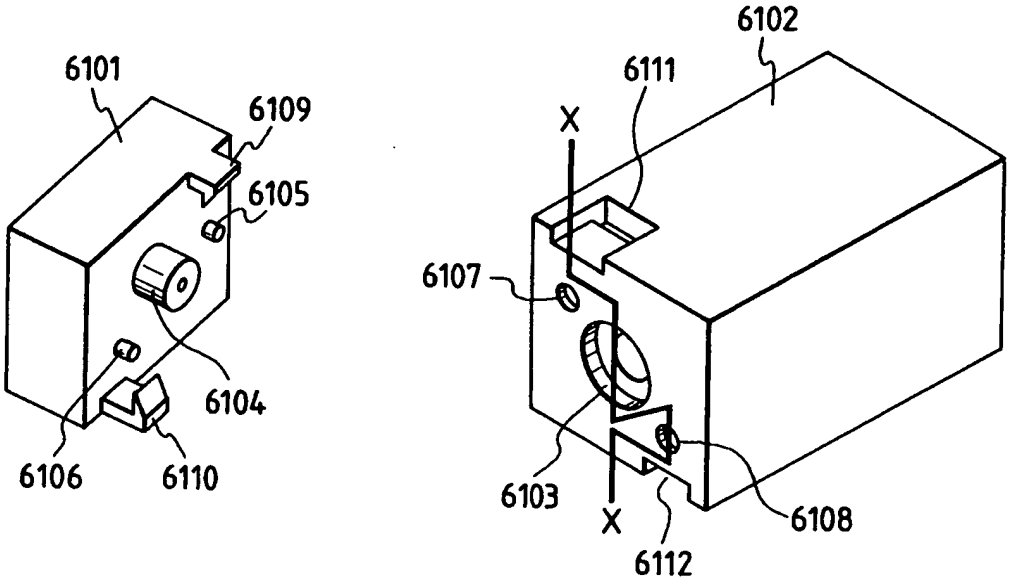


FIG. 60B

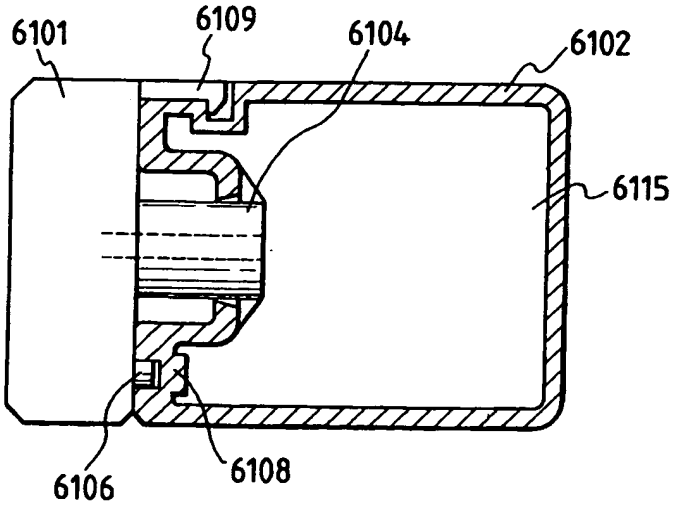
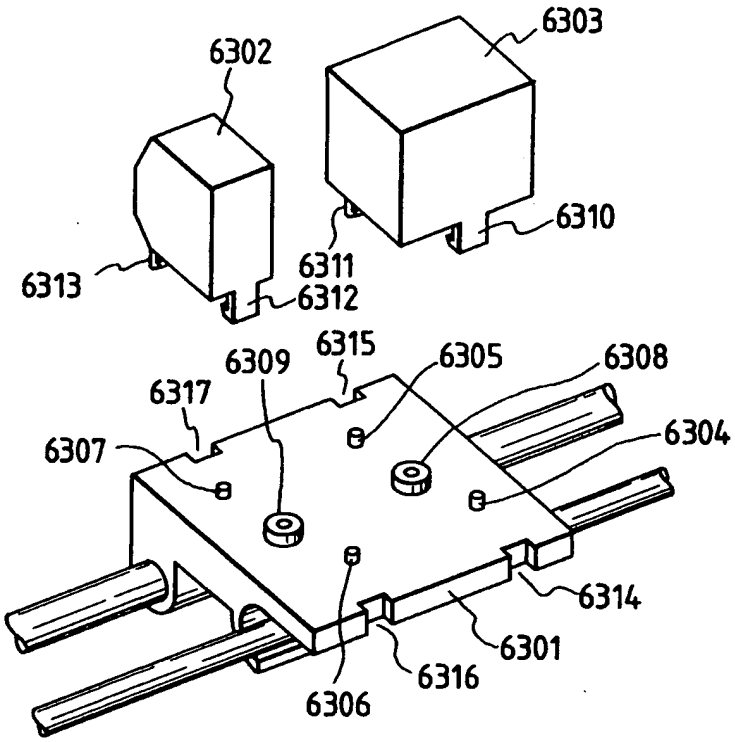


FIG. 61


6303
6302
6310
6313
6311
6312
6315
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6305
6308
6317
6304
6307
6314
6301
6316
6306

FIG. 62

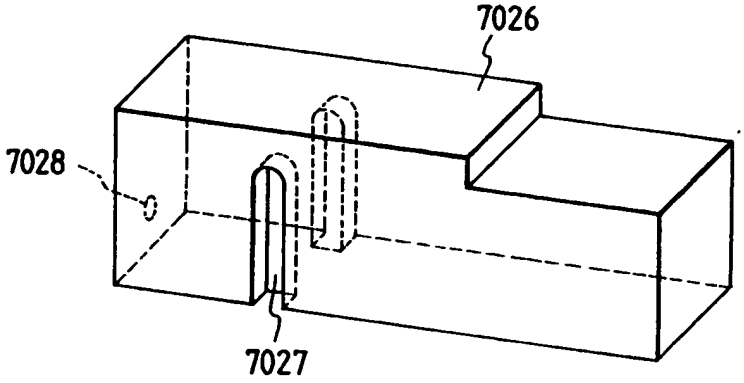

7026
7028
7027

FIG. 63

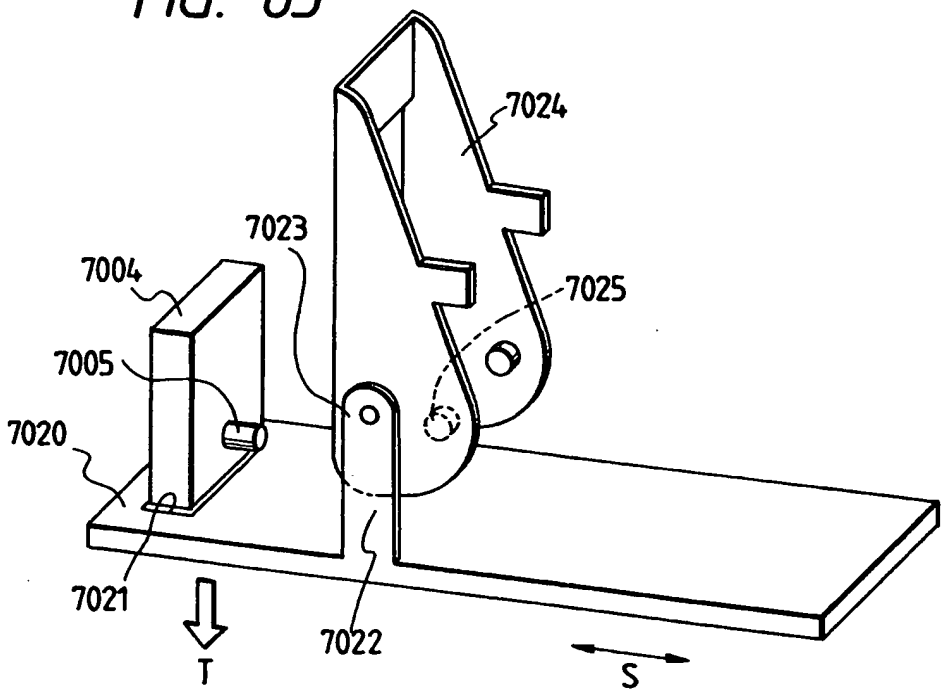

7024
7023
7004
7025
7005
7020
7021
7022
T
S

FIG. 64

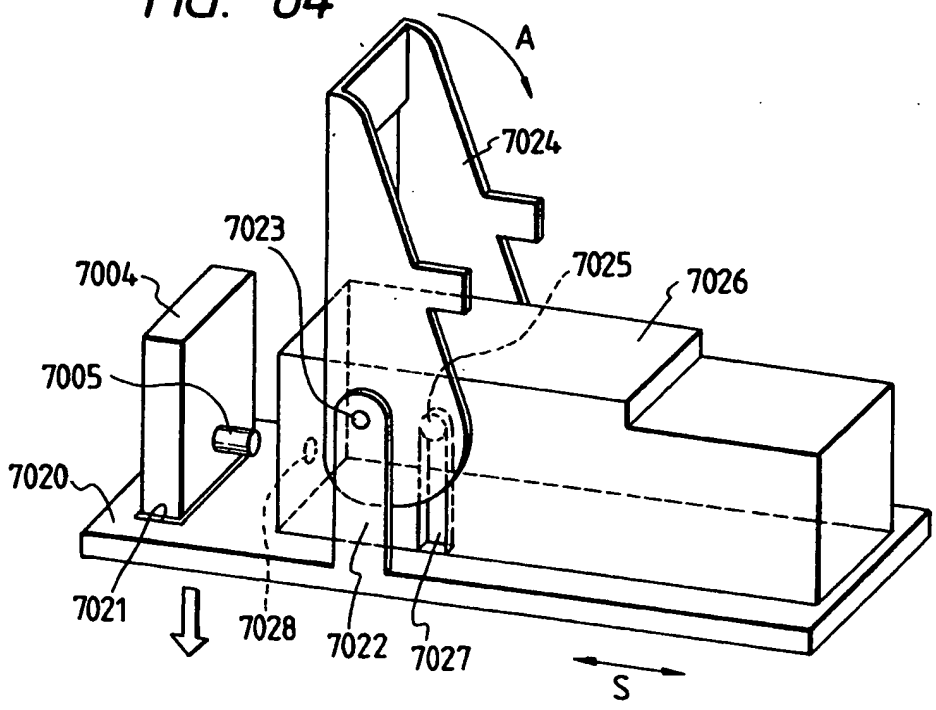

A
7024
7023
7004
7025
7026
7005
7020
7021
7028
7022
7027
S

FIG. 65

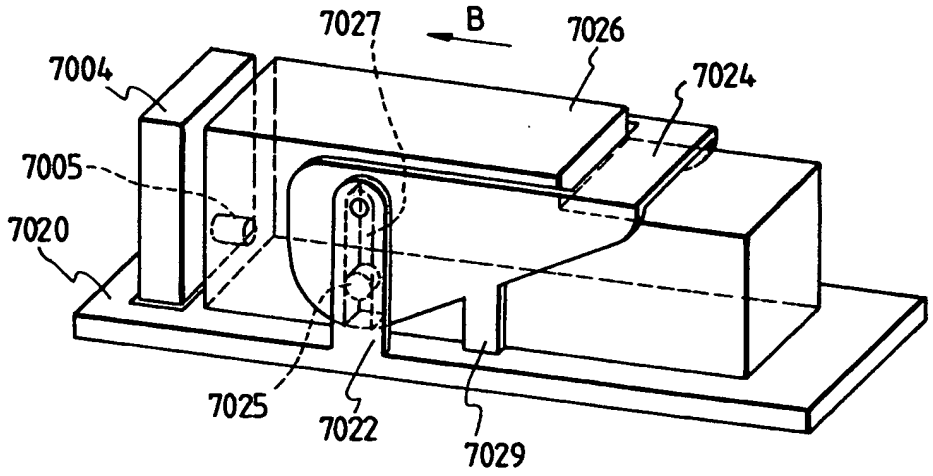

7027
B
7026
7004
7024
7005
7020
7025
7022
7029

FIG. 66

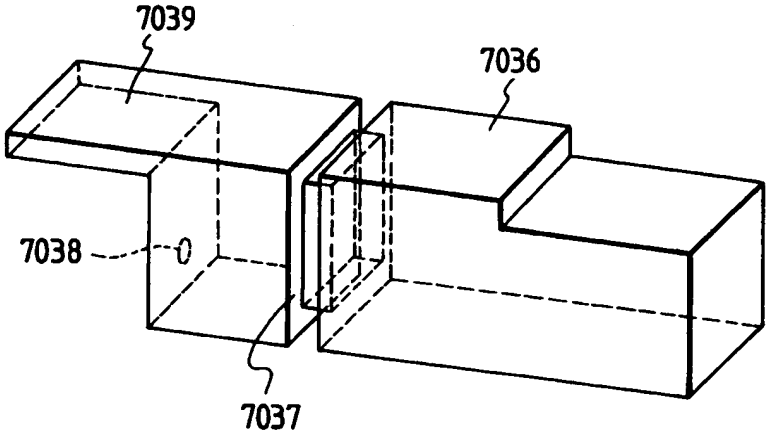

7039
7036
7038
7037

FIG. 67

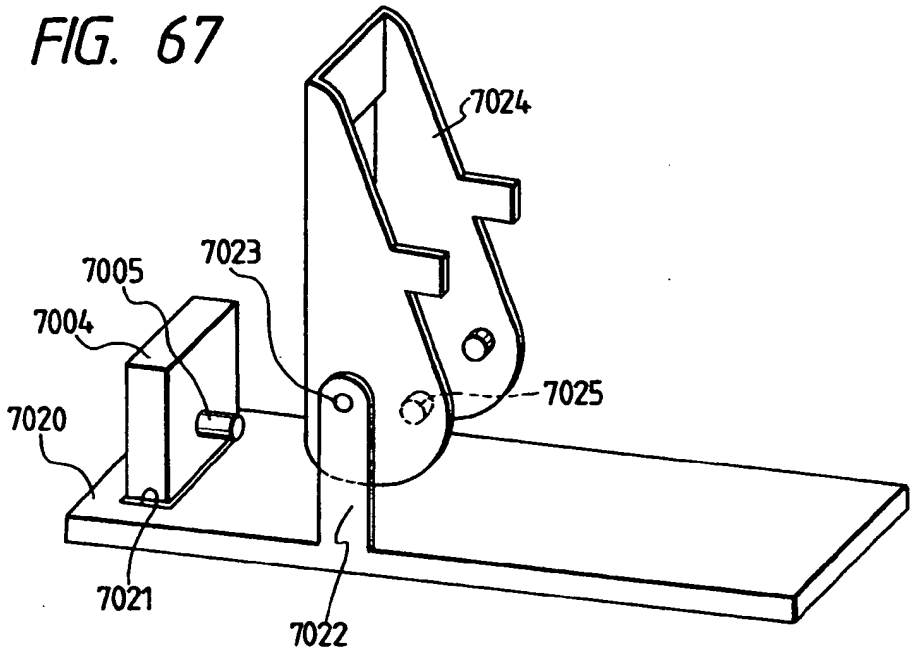

7024
7005
7023
7004
7025
7020
7021
7022

FIG. 68

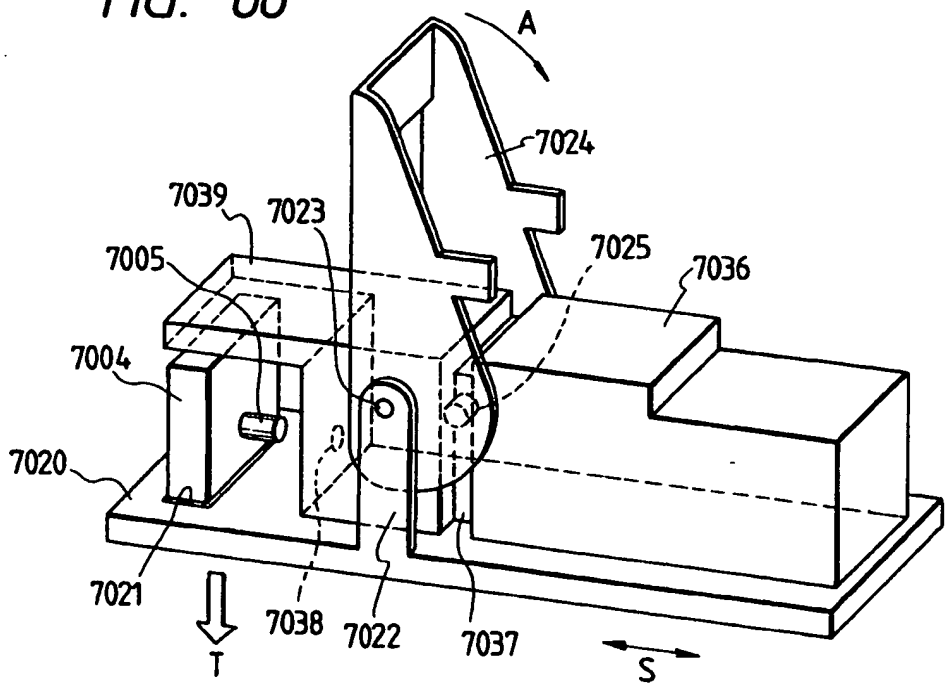

A
7024
7039
7023
7025
7036
7005
7004
7020
7021
T
7038
7022
7037
S

FIG. 69

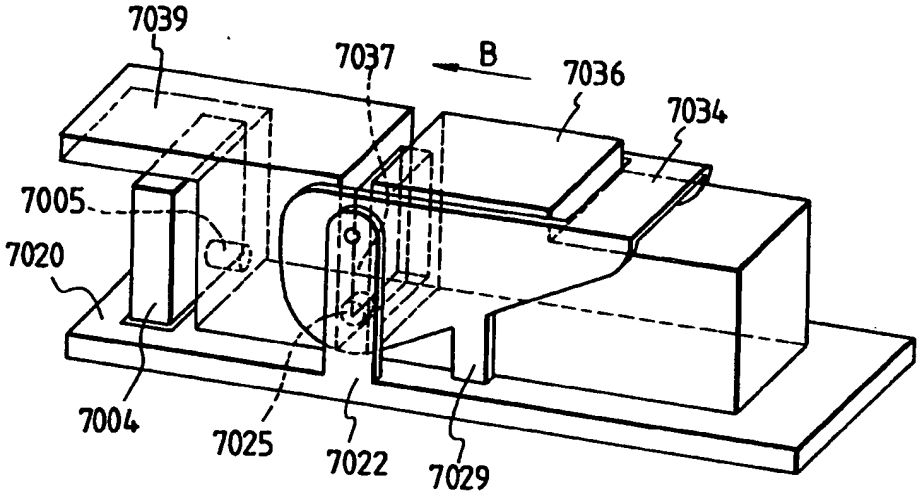


FIG. 70

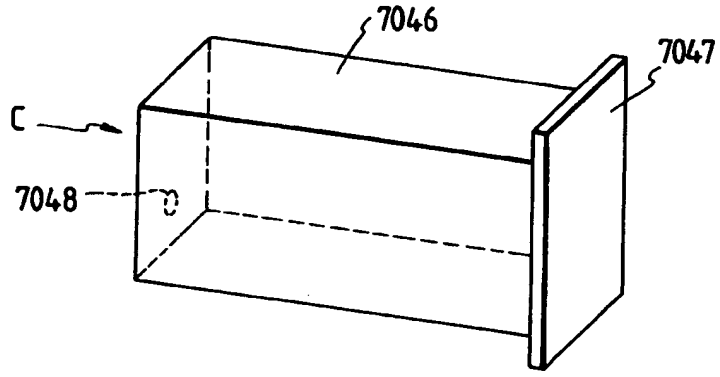


FIG. 71

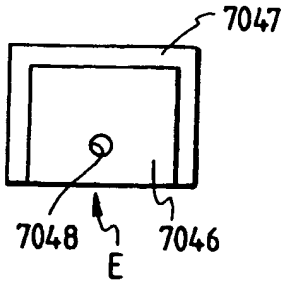


FIG. 72

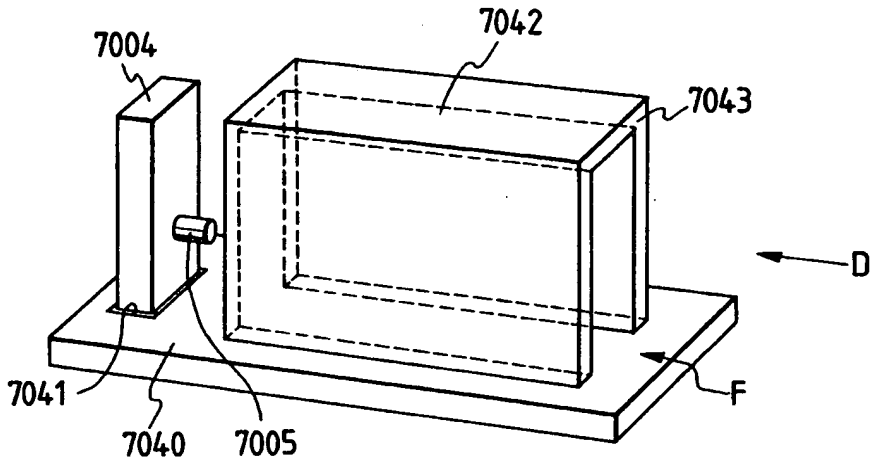


FIG. 73

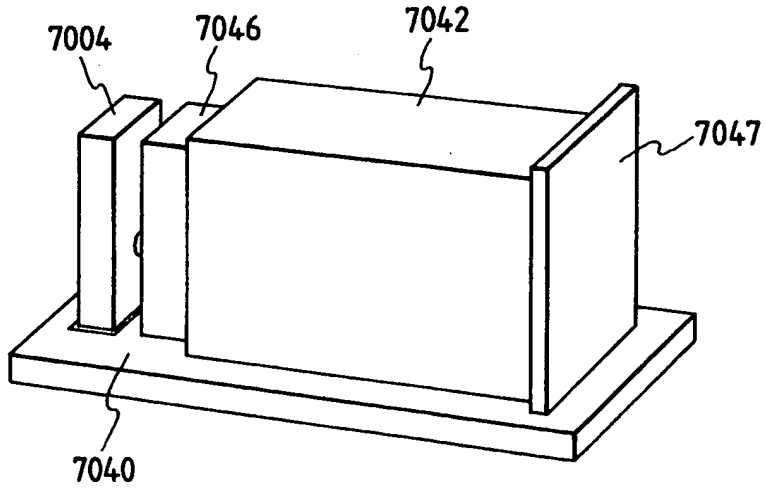


FIG. 74

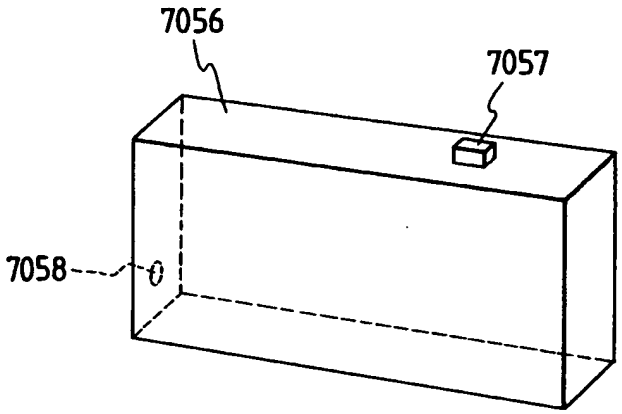


FIG. 75

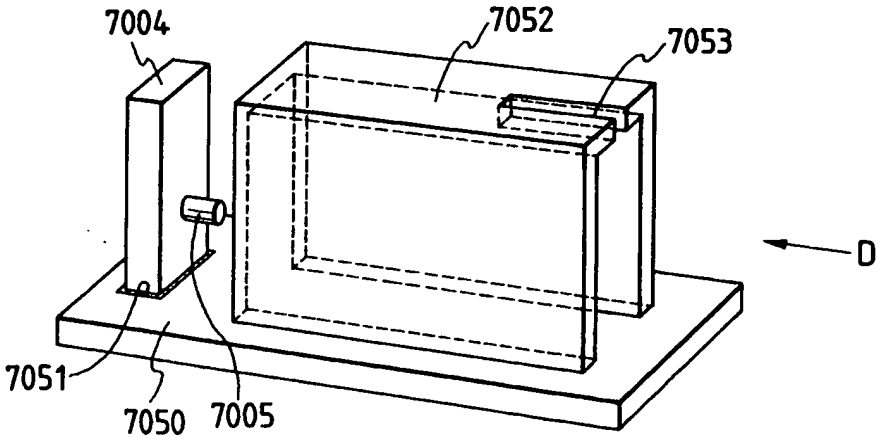


FIG. 76

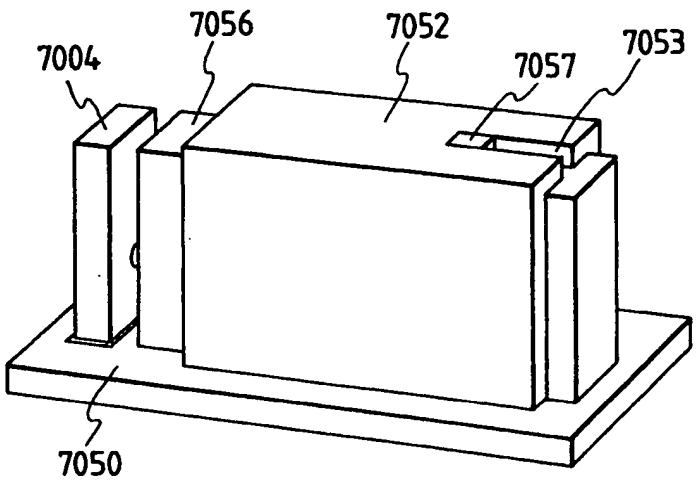

7004
7056
7052
7057
7053
7050

FIG. 77

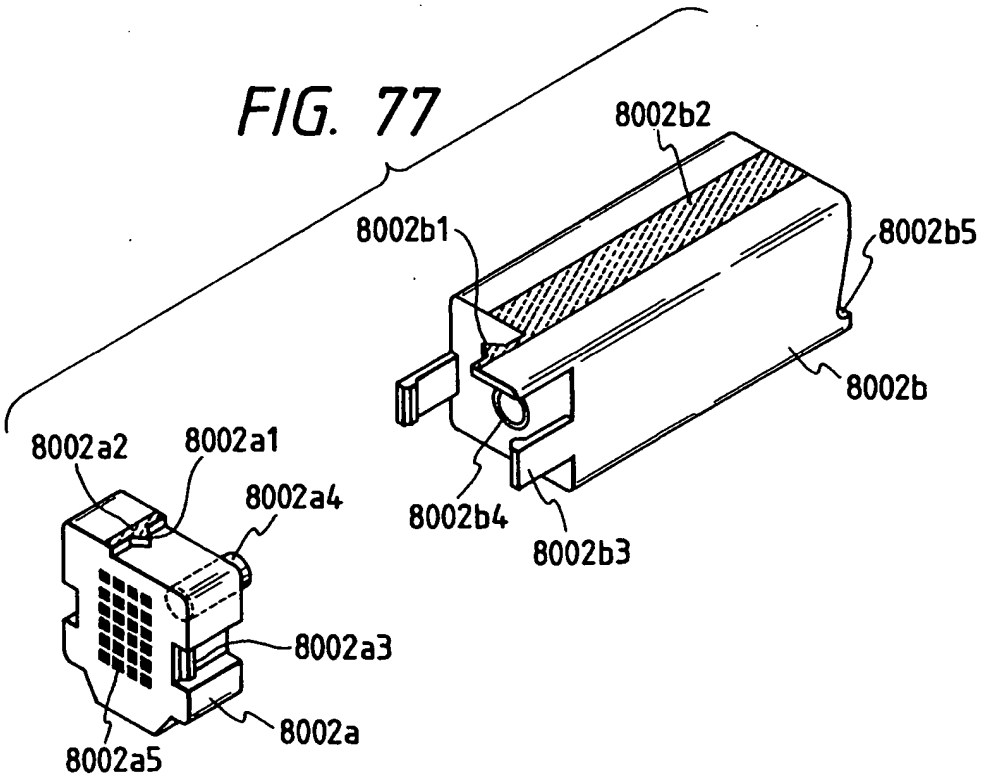

8002b2
8002b1
8002b5
8002b
8002a2
8002a1
8002a4
8002b4
8002b3
8002a3
8002a
8002a5

FIG. 78

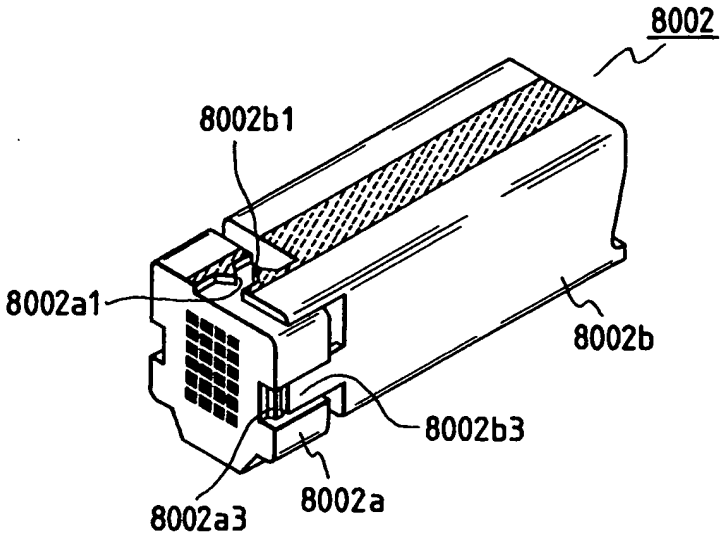


FIG. 79

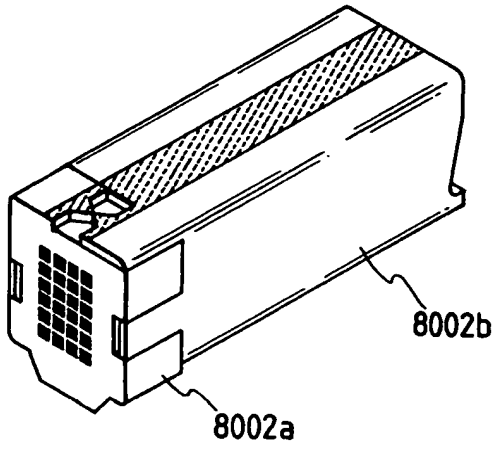


FIG. 80

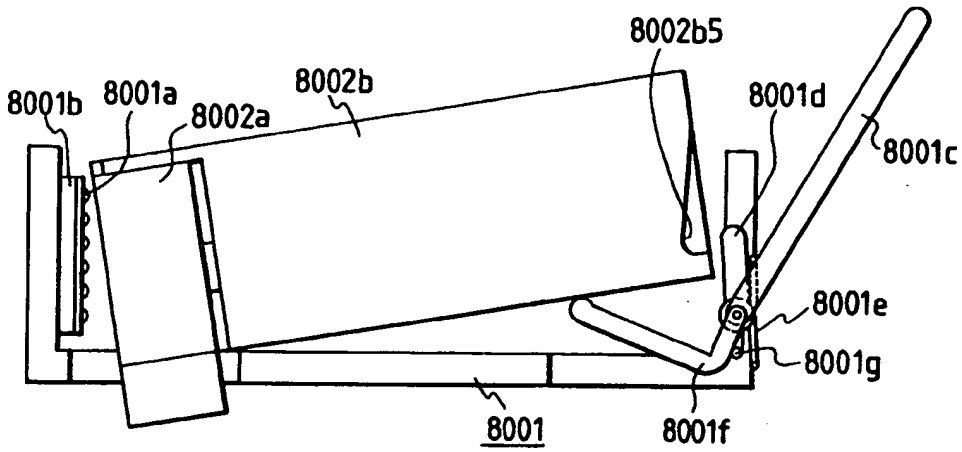


FIG. 81

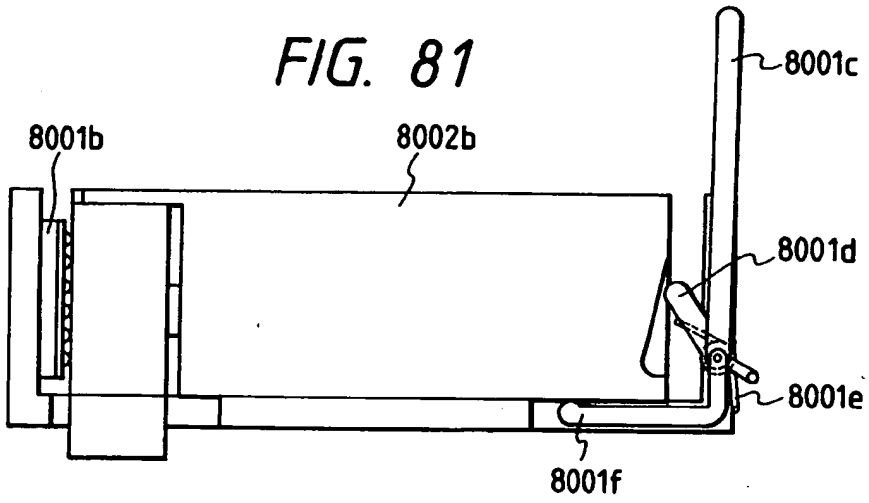


FIG. 82

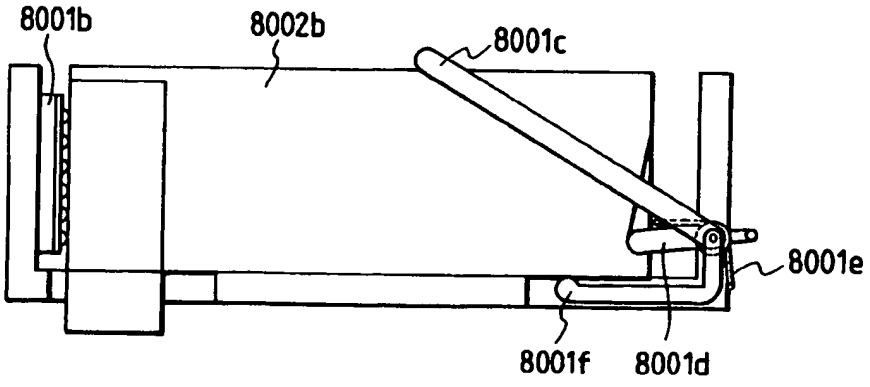


FIG. 83

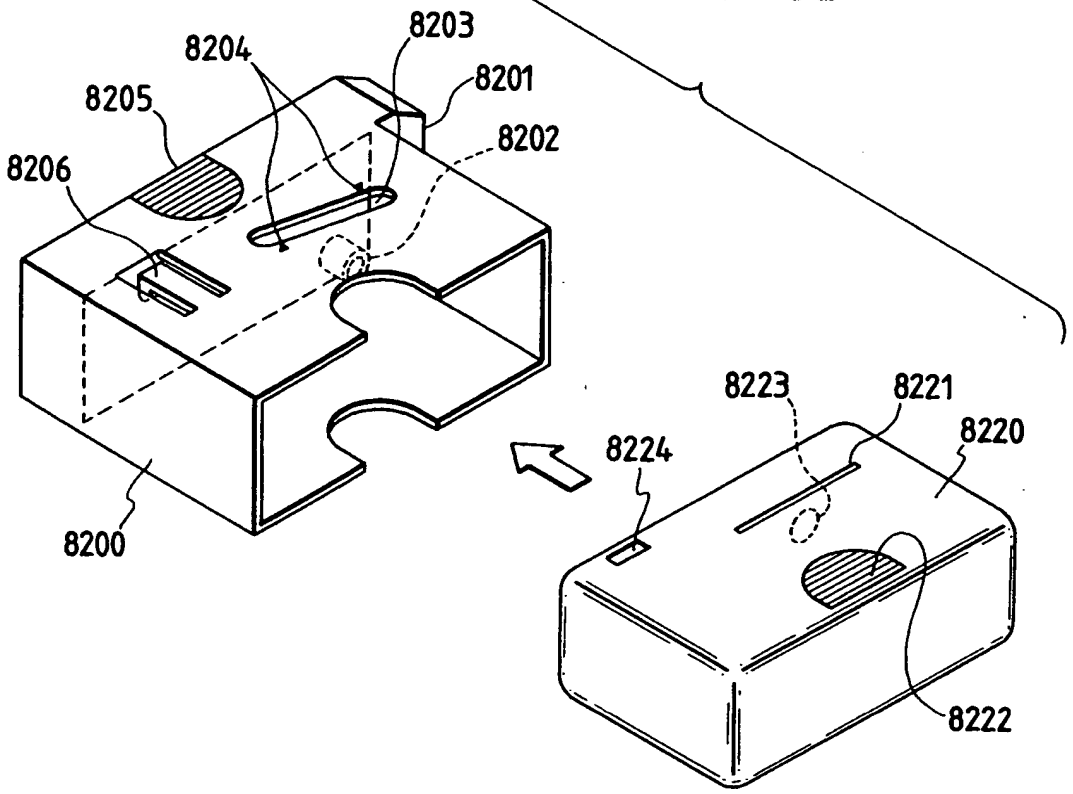

8203
8204
8201
8205
8202
8206
8223
8221
8220
8224
8200
8222

FIG. 84

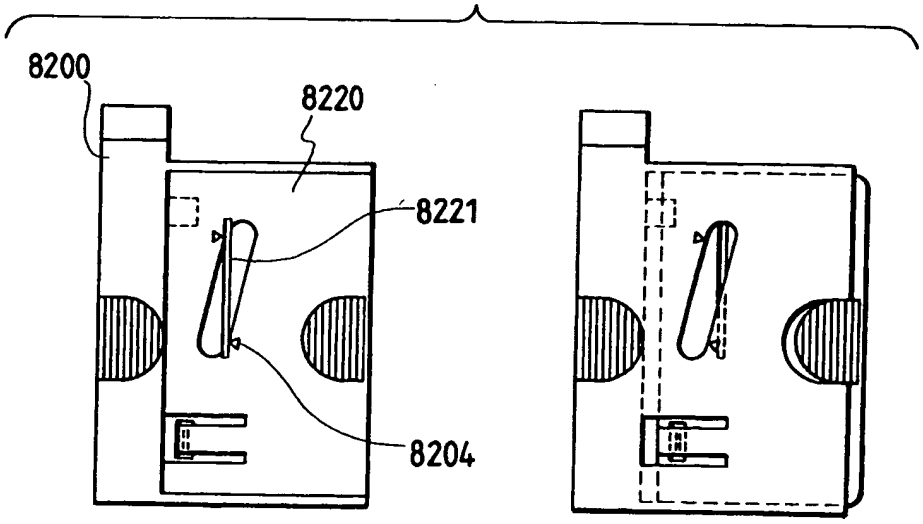

8200
8220
8221
8204

FIG. 85

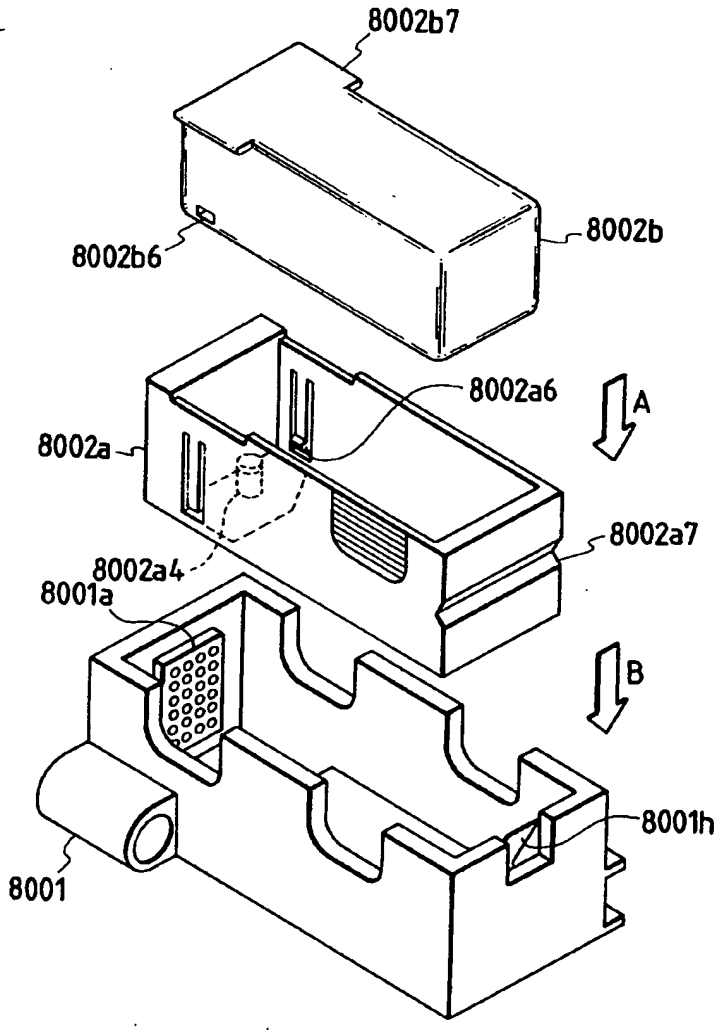

8002b7
8002b6
8002b
8002a6
A
8002a
8002a7
8002a4
8001a
B
8001h
8001

FIG. 86

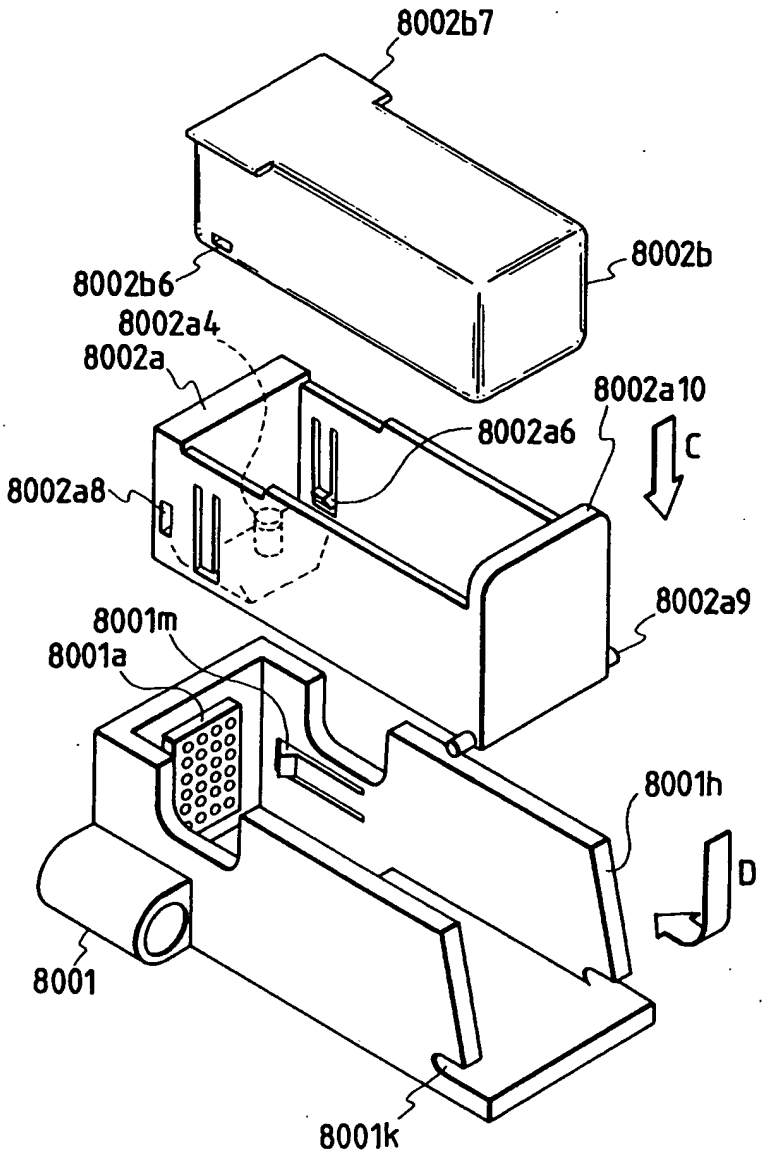

8002b7
8002b
8002b6
8002a4
8002a
8002a10
8002a6
C
8002a8
8002a9
8001m
8001a
8001h
D
8001
8001k

FIG. 87

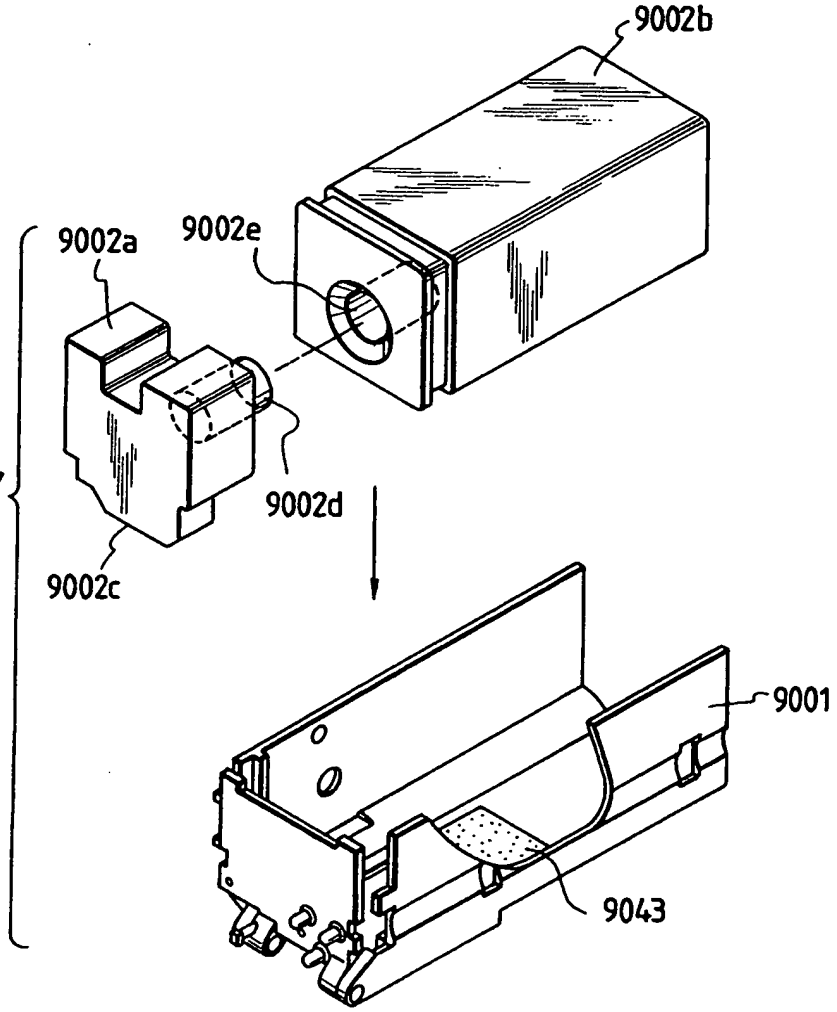


FIG. 88

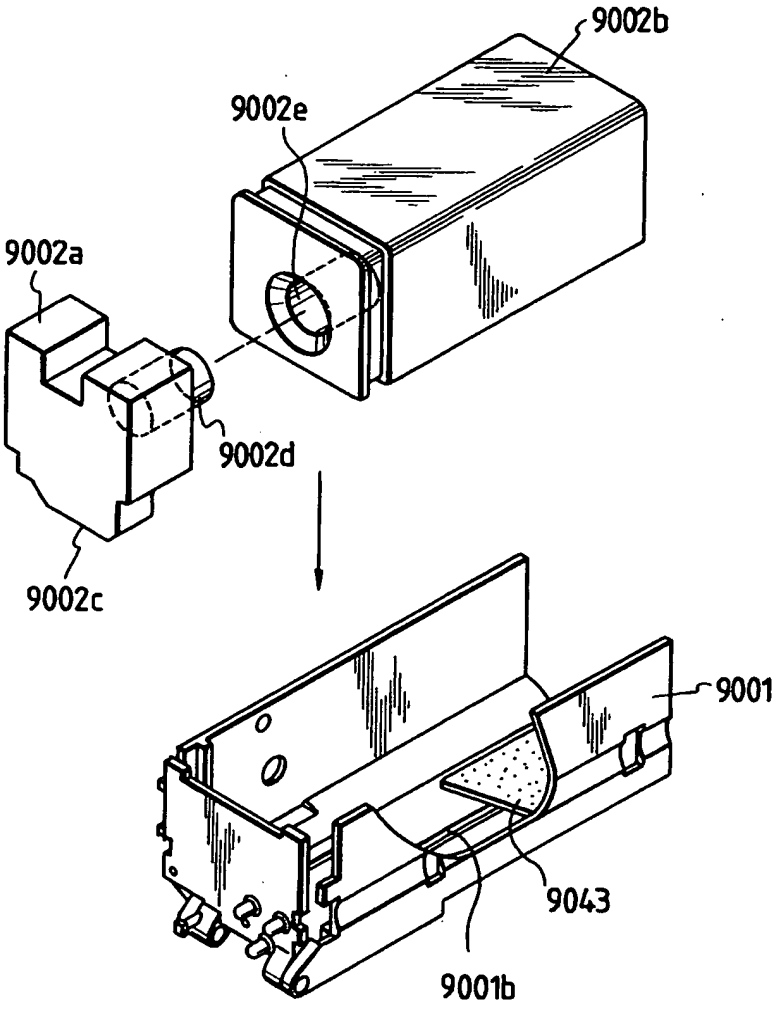


FIG. 89

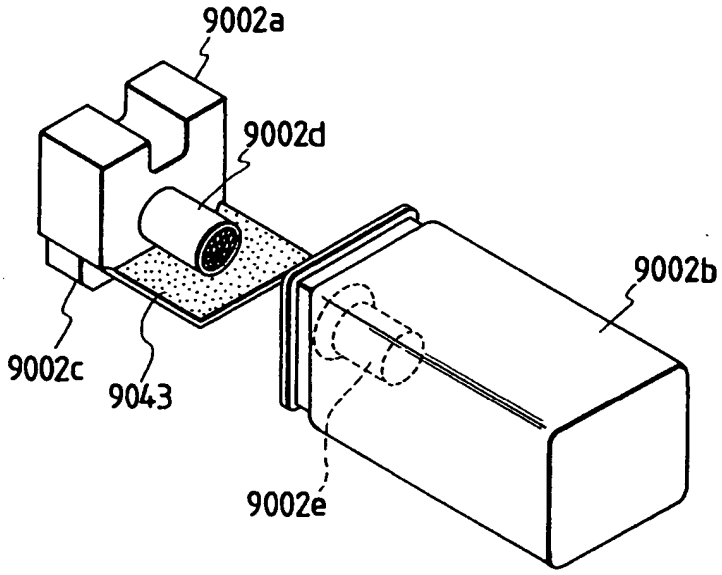

9002a
9002d
9002b
9002c
9043
9002e

FIG. 90

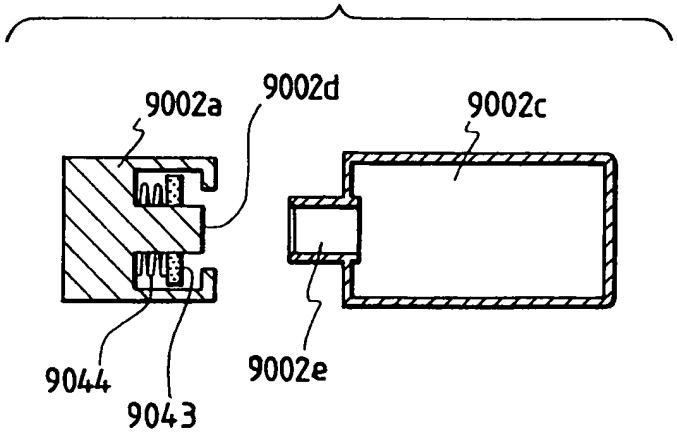

9002a
9002d
9002c
9044
9043
9002e

FIG. 91

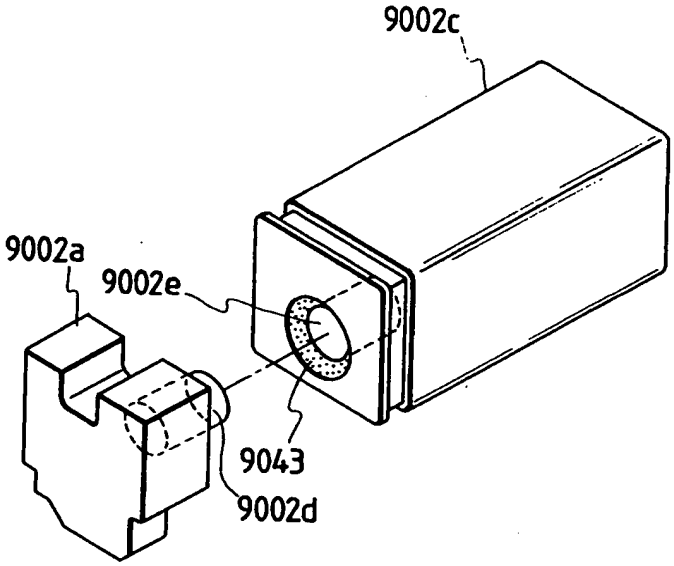


FIG. 92

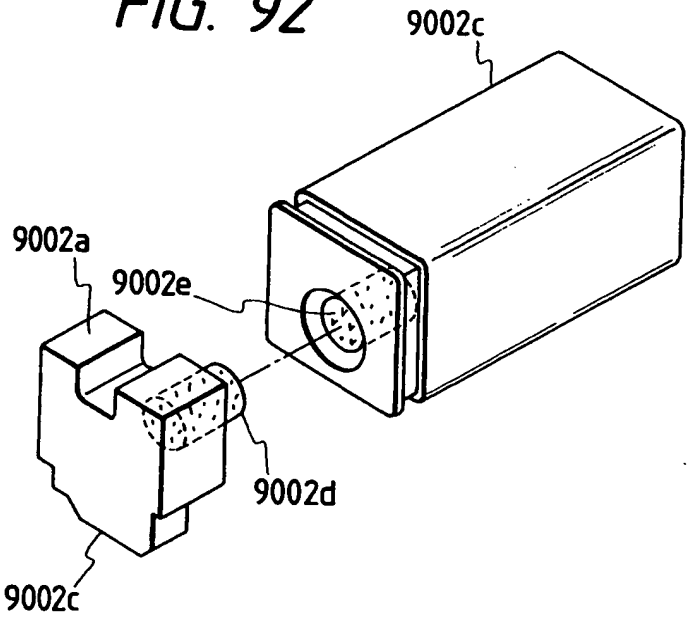


FIG. 93

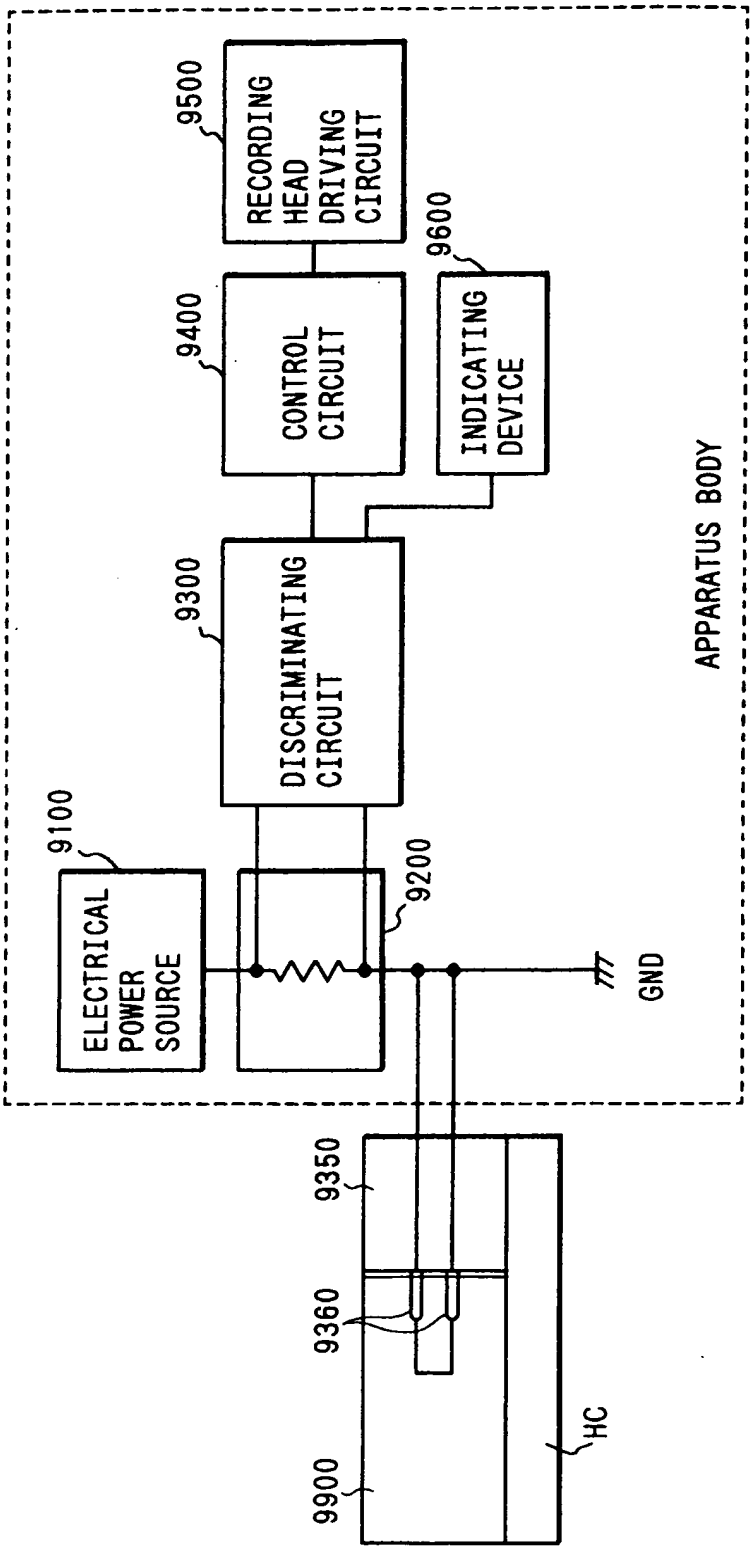
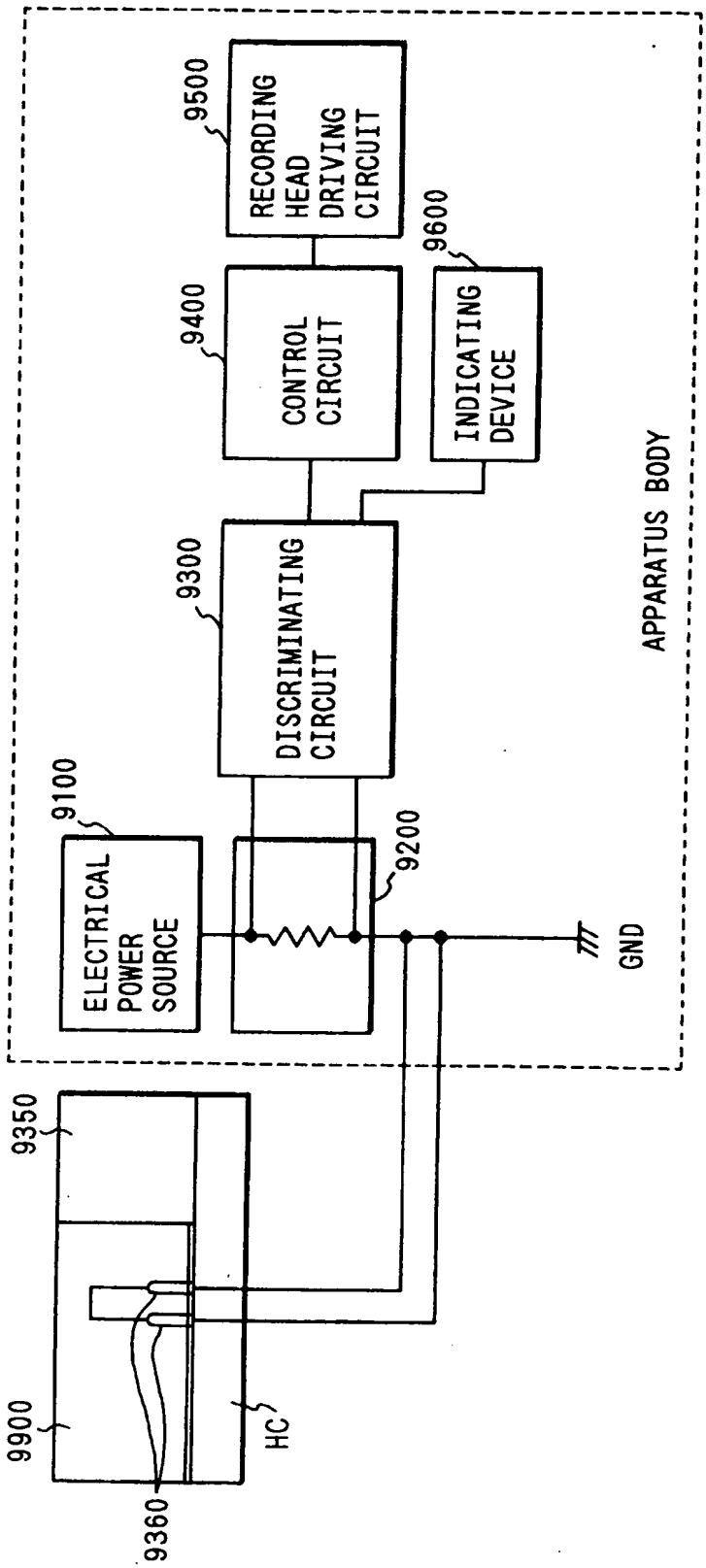

APPARATUS BODY
9500
RECORDING HEAD DRIVING CIRCUIT
9600
INDICATING DEVICE
9400
CONTROL CIRCUIT
9300
DISCRIMINATING CIRCUIT
9100
ELECTRICAL POWER SOURCE
9200
GND
9350
9360
9900
HC

FIG. 94


APPARATUS BODY
9500
RECORDING HEAD DRIVING CIRCUIT
9600
INDICATING DEVICE
9400
CONTROL CIRCUIT
9300
DISCRIMINATING CIRCUIT
9100
ELECTRICAL POWER SOURCE
9200
GND
9350
9900
HC
9360